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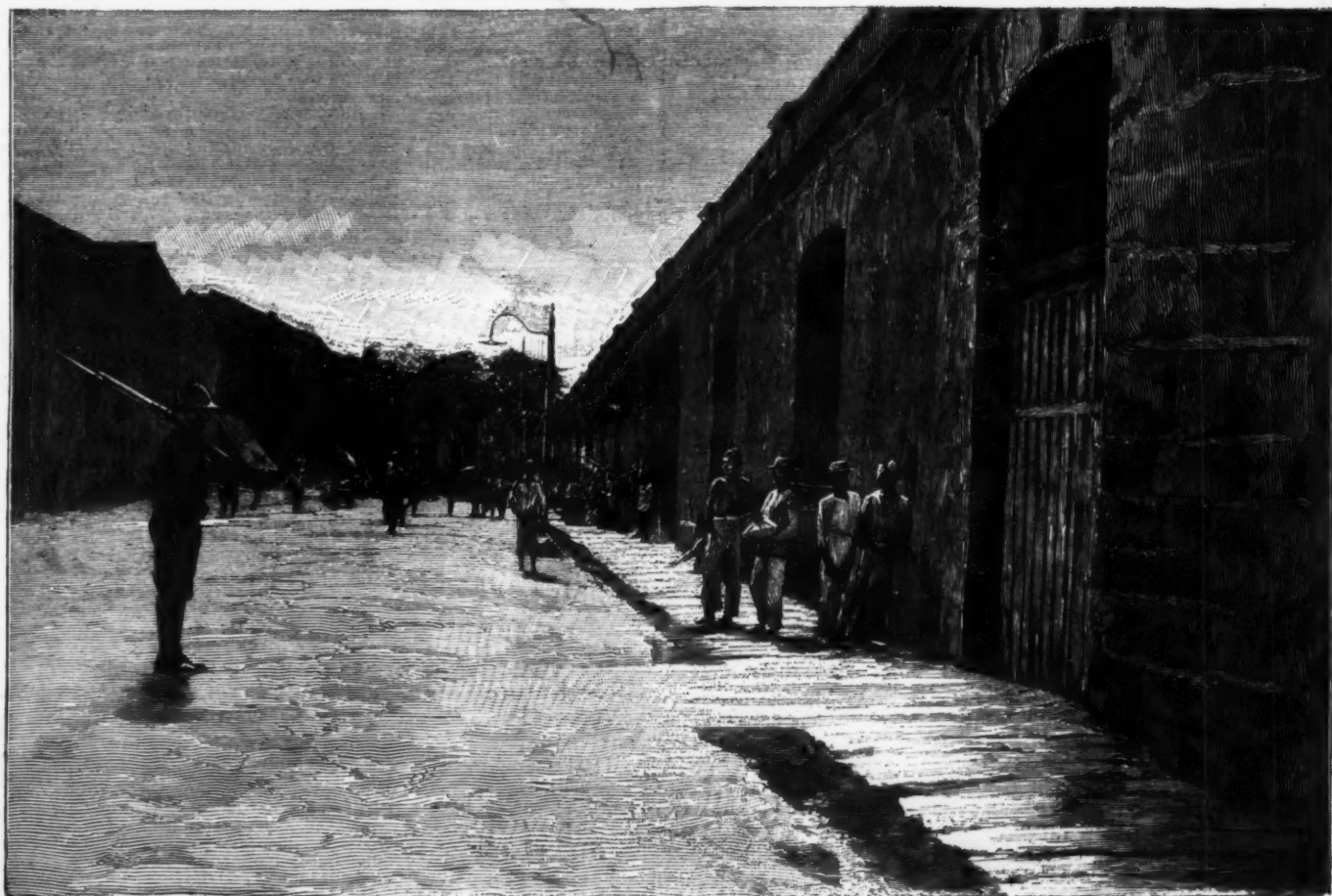
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RUINS OF THE SUBURBS OF TONDO.



PHILIPPINE PRISONERS IN THE CITADEL AT MANILA.

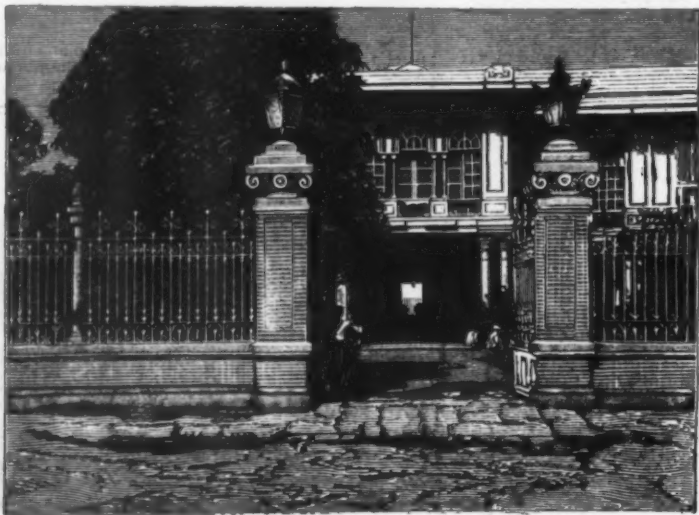
NOTES ON MANILA AND CAVITÉ.

THE arrival at Manila, says a writer in *Le Monde Illustré*, is doleful. Over this port, so bustling of old, and so noisy with the shouts of boatmen, a profound silence has fallen. There are but few merchant vessels to be seen; the roadstead is filled with American armor-clads, which are still threatening; and the steam launches of the latter are the only boats that plow the waters.

This first impression is slightly effaced as soon as one goes ashore. In fact, the Bridge of Spain, which connects the Binondo district with that of Manila, has preserved its habitual aspect of gayety. The presence of the American volunteers alone, in their large, soft

to receive the necessary repairs. Further along we perceive, almost on a level with the waves, some masts and a smokestack. These mark the wreck of a Spanish armor-clad that was sunk before Cavite.

Cavite, at which I landed after a trip of an hour, is now a dead city, in whose wide, deserted streets one's footsteps resound mournfully. Upon the promenade that extends along the sea we find the statue of Columbus, which was decapitated by the women of the city. As may be remembered, this statue, erected to the glory of him who discovered America, was stoned on the day succeeding the destruction of the Spanish fleet. Ingenious is the rage, in truth, that lays blame upon so remote a cause of the misfortunes of the country!



DWELLING OF PRESIDENT SHURMAN, AT MALATE, NEAR MANILA.

felt hats and yellow kahkis, recalls the fact that we have arrived in a disturbed country.

The Escolta, the great business street of the city, is full of strollers, who stop for a long time in front of the shop windows. In the afternoon, about four o'clock, the promenaders go to seek a little fresh air upon the Luneta, where the military band is playing.

It is in the faubourg of Ermita that the majority of the American troops are quartered. These are mostly volunteers, whom the better disciplined regulars are gradually replacing. The latter are the only soldiers that can be profitably employed to fight the insurgents, who naturally take advantage of the want of discipline of the volunteers.

The situation is far from being as satisfactory to the Americans as optimistic cablegrams state, and Mr. Shurman, the president of the civil commission, is making laudable efforts to come to an understanding with the Filipino delegates. The future will tell us; but it seems as if the insurgents were trying to gain time, and were relying a great deal upon the deadly effect of the rainy season.

After passing through the quarters that have remained intact, says the same writer, and after visiting the old citadel, where a few Filipino prisoners were peacefully promenading under the guard of the Americans, I hastened to take a look at the faubourgs and surrounding villages which suffered the most during the last conflicts.

The faubourg of Tondo is no longer anything but a ruin. In the place of houses there is nothing but a

Touched by all these sad things, I re-entered Manila. But here, also, I was to have leisure to reflect upon them, since, from seven o'clock in the evening, one has to shut himself up in the hotel.

The American patrols would have no pity for an imprudent promenader who should take the risk of staying out of the house after nightfall.

ACCOUNT OF DR. PETERS' RECENT VISIT TO THE RUINS IN ZAMBESIA.

DR. KARL PETERS sends us an account of a visit he made recently to some ruins near the river Muira, a southern tributary of the Zambesi, in Portuguese territory, nearly opposite Shupanga. He refers to a passage in the "Atlas Historique" (1705-19), in which it is stated that half a day's journey from the river Mansoro is the fort of Massapa, and near this is the "great mountain of Fura, very rich in gold, and there are people who say that this name of 'Fura' is a corruption of the name Ophir." It is then stated that in this mountain are Cyclopean ruins. It was to find these ruins that Dr. Peters made his journey from the Zambesi; he concludes that the Muira is the Mansoro of the old maps. Dr. Peters, accompanied by Mr. Leonard Puzey, Herr Ernest Gramann, and a number of porters, left the Milamba, on the south bank of the Zambesi, on April 14, in a south-southeast direction. He says:

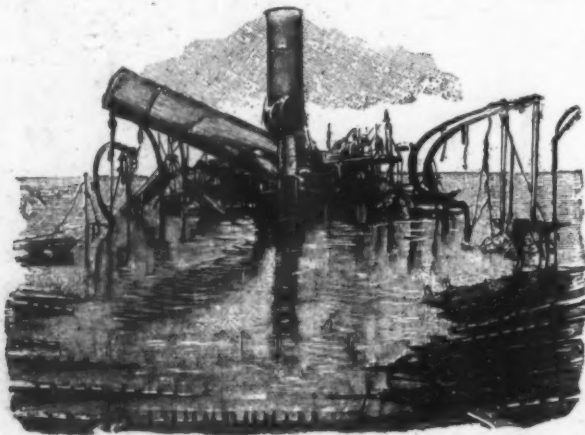
We marched on this afternoon only five miles, and camped at the last great kraal under control of the

bankment of the Muira and went out for an excursion up river with Mr. Puzey and two Somalis. Half a mile on the right and left hand the range was still rolling like the hills of the Neckar above Heidelberg. But then the dark rock steeply fell down, about 800 feet on both sides to the valley of the Muira.

We continued our exploration on the next day, when I moved our camp about two and one-third miles into the very center of the valley, where the river forms a bank of alluvial quartz sand. We could state in the afternoon that the old report, which says that in this mountain the river of Dambarari passes to the north, is quite correct. At its entrance in the south the mountain mass forms two splendid solid rocky mountains of slate, which fall steeply about 1,000 feet down to the river from both sides. I found out later that in fact they must have originally been one mountain through which the Muira cut its way. I have called the mountain on the western side "Mount Peters." Altogether, the valley from south to north is about five miles long. In front of the southern entrance the rocks fall off to the west, some hills skirting the main mountain. On the eastern side they bend to the southeast in a very picturesque semicircle, which has its continuation in the south and toward the southwest, almost forming a circle. The end of this circle is called by the natives Msusi Mountain, and at its foot the great kraal Inja-ka-Fura is situated. It is near one of the hills, parallel to the western ridge, only leaving room for the broad bed of the Muira River, and so almost closing the escarpment round the wide mound south of Mount Peters. On the hill opposite Inja-ka-Fura and the Msusi Mountain we found one of the old ruins of which our report speaks. The whole mountain mass of Fura may have an extension of 80 to 90 English square miles. We had not camped more than twenty-four hours in the Fura Valley when we succeeded in getting some further evidence that we were really on the right spot. Some people came to offer work, and when Mr. Puzey, who speaks the language of the country well, asked them whence they came, they answered from Inja Sapa.

To Inja-Sapa, then, we went the next morning. It is a large native kraal in dense primeval forest, about half a day's journey from the river at its southern entrance into the mountain. We asked the people about Massapa, and were answered that Massapa and Inja-Sapa are the same, that people called it Massapa or Inja-Sapa just as they like. So we had identified one of the chief names of our old map and report, and most likely the very spot on which, some centuries ago, the old Portuguese fort stood. That we did not find remains of this fort is not to be wondered at. The fort was undoubtedly built of wood. Besides, we should have had to explore the dense forest around the kraal for traces of a Portuguese settlement, which we could not do yet. Inja-Sapa lies about five hours' march south of the present Portuguese fort of Tambara.

The decisive discovery for our exploration in this country was made by Mr. Puzey on April 20. I had requested him to go to Inja-ka-Fura to settle certain matters with the chief. He returned at noon, and reported that he had seen the ruins the report speaks of. They are situated, as I have already mentioned, on the hill which runs parallel to Mount Peters, and look down upon the circular valley formed by the escarpment which I described above. The ruin is about two miles distant from Inja-ka-Fura. I went to this ruin in the afternoon with Herr Gramann, and we ascended it, undoubtedly the first whites who ever did so for centuries, as Mr. Puzey had only looked at it from the bottom. Through a dense undergrowth, over vast debris, we had to make our way. After half an hour's exertions we stood on the platform of the hill, and had a look over the beautiful country at our feet through which the Muira River bends in wide windings. On the platform we noticed what I took at once for the remains of an ancient ground-wall following the edge of the ridge. Then we went down half-way again over masses of stones and debris, and we stood in a courtyard before an ancient Cyclopean wall, partly fallen to pieces, partly rising up to twelve feet to fifteen feet in height. In a mighty circle it



SPANISH VESSEL SUNK BEFORE CAVITÉ.

heap of rubbish, the fire not having left a stone upon stone. Here the conflict was terrible and merciless; and the insurgents, having one night forced the American lines, were repulsed only after a long and bloody struggle.

The village of Paco, too, is almost entirely destroyed, and in its church, while on fire, there perished a host of natives who expected to find an inviolable asylum therein.

In order to escape all these scenes of desolation, I resolved to visit Cavite and pass over the places of the famous naval combat. Everything here recalls the fact that the sinister battle is still recent. Here we see a Spanish ship that has just been floated and is to be taken, with great trouble, to Hong Kong, in order

Portuguese administration, about an hour's distance from the Muira River, where we had to enter Macombe's country. This river (which is no other than "la rivière de Dambarari") we struck next morning by seven o'clock and followed its dry bed eleven miles upward. At ten o'clock, advancing my caravan with Mr. Puzey, I saw for the first time right in front of me the strangely shaped outline of the Fura Mountains. Two comely shaped black rocks, through which the river runs, which here suddenly shows real water, stand like the posts of a gate on either side of the stream. The whole mountain is of quartzite slate, and gives with its dark color an almost weird impression, the more so as it is entirely devoid of population. I pitched my tent under the hill on the eastern em-



SUNKEN SPANISH VESSEL SET AFLOAT IN THE BAY OF MANILA.

runs around the slope of the hill to the right and left, forming with the hill behind the courtyard I spoke of. It appeared that on our way up hill over masses of small stones and boulders we had climbed over a part where the wall was broken to pieces by old age and African elementary powers. With a feeling of awe I stood in the midst of these remains of ancient, very ancient, human activity.

On the next day I had a decent road cut to the top of the hill and down again to the wall, and now we could study our find with more ease. The results, in short, are the following. We discovered toward the center of the top another ground wall which had undoubtedly been a part of the building, maybe a temple, maybe a store-house. This wall had been worked

tainous regions of Kordofan and Darfur on the west and of the Abyssinian frontier on the east, would be impossible. Iron ore is found in the Bahr-el-Ghazal province, and also in Darfur; while gold mines were at one time worked in the mountains south of Fazogl. Could coal be discovered it would make a great change in the whole question of the Sudan. In a few years' time it is probable that the Geological Survey Department of Egypt will be able to depute parties to examine the Sudan. For the present nothing can be done. —Journal of the Society of Arts.

RESIDENTS of this State customarily look to the West and South and to foreign countries for precious and semi-precious stones in their natural state, but here and there may be found some of the most beautiful known. Underlying this city are gem-bearing quartz veins; but these vaults are now locked and inaccessible. The seeker after precious stones long ago gave up his place to the real-estate dealer, who has made more money in building up than the other could have by digging down.

An idea of the variety and beauty of the precious stones found in New York State may be gathered from a visit to the Tiffany-Morgan collection of gems, belonging to the State cabinet at Albany, and to the Mineralogical Club's collection in the Museum of Natural History. On Manhattan Island are found the yellow aquamarine, or beryl, the pale-green beryl, and the small, transparent red garnet, the quartz veins bearing them traversing the archaean rocks. The same veins occur elsewhere in the State toward the Adirondack region. In Lewis County, however, precious stones are most abundant. Here are found, in particular, great quantities of purple and red garnets. At Newcomb, in the same county, beautiful crystals of brown tourmaline are found. Prof. Beecher of Yale made this discovery some time ago. In Richville, in the township of De Kalb, the finest crystals of pyroxene are picked up from time to time. Cut into gems weighing from three to thirty carats each, they possess a peculiar charm. They are of a rich, oily green, differing from the tourmaline, peridot, or green garnet.

One of the most valuable of the native precious stone is titanite or sphene, which is found in the "Tilly Foster" mine, near Brewster's, in Putnam County. This crystal is of a brilliant golden substance, and a great favorite with lapidaries. Cut into gems, it shows a greater play of color than the diamond itself, it is said by Mr. Kunz, the government expert. It would be one of the most remarkable gems but for its softness; in beauty and coloring it is unmatched. A single stone, in its natural form, brings from \$100 to \$300. In excavating for the ship canal on the upper end of New York Island, crystals of smoky quartz were found in blasting the magnesium limestone. So exquisite in their crystallization and natural polish were they, that they had only to be cut into smoky topaz.

Gouverneur, in St. Lawrence County, seems to be the home of the tourmaline. One of these stones, of the collection of Elihu Root, Sr., is as thick as a man's neck. Occasionally the crystals are transparent enough to afford gems of from one to five carats each. In Orange County, near Sussex, on the New Jersey line, crystals of sapphire are found, but they are not sufficiently transparent to be of much value. Recently they have been referred to in certain scientific articles because their occurrence in a limestone, such as that in which they are here found, is identical with the occurrence of the true ruby in the valley of the Mogok, Burma, where the most highly prized pigeon-blood rubies are found. All the way from Lewis County to



they are worked is quartzitic slate. The whole of the ruin is built after the general ancient Semitic pattern. The Cyclopean wall skirts the hill about half-way between the bottom and the top; on the top of the buildings, the boarding place and likely the temple were standing. The remains of a ground-wall along the edge of the top lead me to believe that a second wall formerly ran round the platform itself. To explore the ruin properly it will be necessary to send a scientific expedition with a proper outfit for such excavations. The debris has to be removed, and this, I am sure, will take considerable time. Why the old conquerors chose this spot for their fort is easy to see. The Muira touches the bottom of the hill, so water was handy. A second river we have discovered at the back of the ruin. From the top they had an outlook over the wide plain before them, while they had the bulk of the Fura massive at their back. From their fort they commanded the plain as well as the mountain. I have called the hill on which the ruin stands after its discoverer, "Puzey Hill."

Mr. Puzey some days later found a second ruin west-northwest of the first on another head of the same ridge, looking over the plain in the same direction. I am certain we shall find still more of these Cyclopean buildings when our time, which now is otherwise occupied, permits of a more extended exploration.—London Times.

FOREST AND MINERAL WEALTH OF THE SOUDAN.

THE following information, extracted from a report by Sir William Garstin, K.C.M.G., on the Egyptian Soudan, received by the Foreign Office through H. M. Agent and Consul-General at Cairo, is taken from The Board of Trade Journal.

A very possible source of future wealth to the Soudan lies in the vast forests which line the banks of the Upper Blue Nile and extend, in an easterly direction, to the Abyssinian frontier. In the Bahr-el-Ghazal province also, particularly in the Bongo country, large forest tracts exist.

The ebony tree (*Dalbergia melanoxylen*) is met with south of Karkau, on the Blue Nile, and again in the vicinity of the Sobat River. This tree does not, in these latitudes, attain to a very large girth, 9 inches being apparently its maximum diameter. It must, however, be very common in these forests, as most of the principal houses in Omdurman are roofed with it. The value of *Acacia arabica*, from which the white and red gum is obtained, is well known; while the other kinds of acacia, such as *Acacia nilotica* (in Arabic "Sant"), is the chief source of the fuel supply.

A bamboo is met with in the ranges of hills to the south of Famaka, and, according to some, "mahogany" is found in the forests round Fazogl and in the Beni Shangul country.

The means of transporting such woods can only be by the river. Unfortunately, neither the ebony nor the acacia will float in water, and, therefore, such transport is debarred in these cases. If a good and serviceable timber tree can be discovered in the Blue Nile forests which can be floated down the river to Egypt, a large source of revenue will undoubtedly have been found. Extensive saw mills might be erected at Assouan, utilizing the power available at the dam now under construction, and an important timber trade might one day arise.

On the White Nile, in the Bongo and Rohl districts, the India rubber creeper (*Landolphia florida*) is found in great profusion. If the rubber yielded by this creeper be not of quite so good a quality as that obtained from the Assam India rubber tree (*Ficus elastica*), it is

introduction into the country is well worth attempting.

It is very much to be hoped that a scientific examination of the Soudan forests may ere long be carried out under the superintendence of an expert. An Indian forest officer (from Burma for choice) might be deputed for this purpose. It is certain that much valuable information would be obtained from his report. Such an appointment needs no recommendation—its necessity is obvious. A trained forest officer could, moreover, render good service by advising the government as to the best method of preserving the valuable fuel supply which at present exists on the banks of both rivers. This supply, although apparently inexhaustible, must speedily diminish, unless the cutting and felling of the areas is carried out upon some regular system which will permit of the young trees growing up and replacing those cut down. It is, of course, inevitable at present that the felling should be carried



out in a wasteful manner. Fatigue parties are landed from the boats, and are required to cut the largest amount of wood in the shortest possible time. The men have no idea of the value of the trees, and naturally select those which are nearest to the water and easiest cut. Should this practice be continued, it is certain that a few years must see a great diminution in the belt adjacent to the river. On the Blue Nile even the valuable gum-producing acacias are being felled for fuel.

Minerals.—Very little is known regarding the possibilities of mineral wealth in the Soudan. Until the country is more settled, an investigation of the moun-

Coney Island there are boulders of chatoyant, iridescent feldspar, known as Labrador spar. Masses have been broken from the original deposit at Keeseeville and scattered during the glacial period, until now they lie all the way to the terminal moraine in Prospect Park, Brooklyn. The spar exists in such quantities in one of the rivers in Lewis County, and the colors are so beautifully brought out, that the river has been called Opal River. Labradorite shows a play of red, green, blue, purple, and yellow—like a peacock feather—where it is fractured or cut, if the light strikes it in a certain way.

Although, strictly speaking, it is not a precious stone,

the pearl has been found in many of the fresh-water brooks and rivers in this State. Pearl River in Nyack has produced numbers, as have also several of the rivers in St. Lawrence County. These pearls bring from \$1 to \$100 each. Generally they are not white, but much interest attaches to the tinting—pink, violet, purple, and brown, the pearl being always the color of the shell in which it is formed. The so-called "Lake George diamonds" are more beautiful than valuable. When found in their natural setting of calciferous sandstone, they are more beautiful than the diamond of the African mines when it is first brought to light. They are found in great profusion in Herkimer County, and they are usually set in pins and charms. Jewelers say, however, that nowhere do they look so well as in their natural state, and mineralogists discover them always with delight. The crystals, when they are fine, are snowy white, like Carrara marble, and when free from flaws, very beautiful. Sometimes they are found so minute that, when carefully sorted from the mud, it takes from 70,000 to 400,000 to weigh a single ounce; and each crystal is as perfect as the largest, having eighteen perfect faces. Generally, the so-called Lake George diamonds sold in cities are no more crystal or quartz than are rhinestones bought in Paris cut from Rhine pebbles. The name is merely a catch-penny one.

Rose quartz is the mineral Bedford contributes from its coarse granite. It is a shade of pink not excelled, if equaled, by any found elsewhere. A mineral resembling jade is the moonstone peristerite of Jefferson County. This is a white substance, with a blue play of color. Wallastonite is found at Bonaparte Lake. Through the entire terminal moraine pebbles of black jasper nearly a foot across can be found. They are an intense black, and are known as basanite or Lydian touchstone. They are used by jewelers to determine the carat of the gold.

In his report to the United States Geological Survey on "Gem Production in the United States," just issued, George F. Kunz says concerning another semi-precious stone, and its use in the making of stained-glass windows: "Plum Island—one of the broken line of moraine islets reaching from the northeastern point of Long Island and across the Sound to Watch Hill, R. I.—abounds in pebbles of variously colored quartz, derived from the disintegrated rocks of the Connecticut shore, and carried southward to the upper or second moraine by the ice-sheet. Many of these pebbles are very richly colored—red, yellow, purple, etc.—and have been locally called agates, and collected, both here and on the neighboring Goose Island, by parties from Connecticut. The pebbles are used for the same purposes as stained glass—that is, leaded together—the iron staining showing beautifully by transmitted light. This form of window effect was introduced by Mr. Louis C. Tiffany. The pebbles are very abundant, and are continually rolled, washed, and polished by the surf, and sometimes piled on the beach in windrows. One or two persons make a business of visiting the islands in a sloop and gathering the best colored and most attractive stones."—New York Evening Post.

AN IMPROVED CONTINUOUS-COMBUSTION GENERATOR.

A SIMPLE, instantaneous internal-combustion generator, in which gas or oil vapors are mingled with a proper amount of air to obtain perfect combustion, has been patented by Eugene P. Woillard, of Palm Beach, Fla. Of the accompanying illustrations, representing the apparatus in its preferred form, Fig. 1 is a vertical section through the generator, showing its construction. Fig. 2 illustrates the generator applied to a motor-car. Fig. 3 represents a rear end view of a horseless carriage with the generator and coacting apparatus in position.

In Fig. 1 the combustion chamber is indicated by the numeral 1. From the combustion chamber a neck, 2,

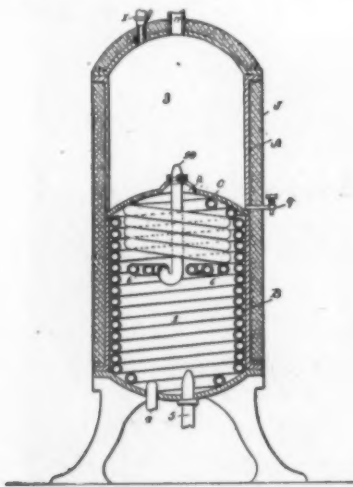


FIG. 1.—LONGITUDINAL SECTION THROUGH GENERATOR.

leads into the mixing chamber, 3. Through the bottom of the combustion chamber an induction pipe, 4, passes, which is bent into a coil and forms a lining, B, for the combustion chamber, an opening being left at the center for the injection pipe, 5. The pipe, 4, coils around the inner walls of the chamber until it reaches the crown sheet, C, where it also forms a lining, an aperture being left in the center. After lining the walls of the combustion chamber, the pipe, 4, is bent into a series of flat coils, 6, having a central passage through which the end of the pipe, 4, is thrust in order finally to emerge from the neck, 2, and project into the mixing chamber, 3. The bottom of the mixing chamber is formed by the convex crown sheet, C, so that the water of condensation can be drained off by

the cock, 9. By providing the chambers, 1 and 3, with a flared-neck tube between them, the combustion chamber is kept clear of steam or moisture, leaving only pure air to form a perfect combustible mixture with the gas or oil vapors. After the products of combustion have passed through the neck, 2, and have mingled with the steam issuing from the nozzle, 10, they are conveyed by the eduction pipe, 11, to the motor. In order to ignite the first charge in the combustion chamber, an electric spark is used.

Either a hand-pump may be used to start the generator, or the pressure of air and oil-vapors or gases stored in a tank. Should the pressure within the generator pass a safe limit, the safety-valve, I, will be automatically opened.

The motive fluid generated by this apparatus has the advantage of gas, hot air, and steam, without the disadvantages of a falling off in pressure.

In operating car-motors by means of this generator,

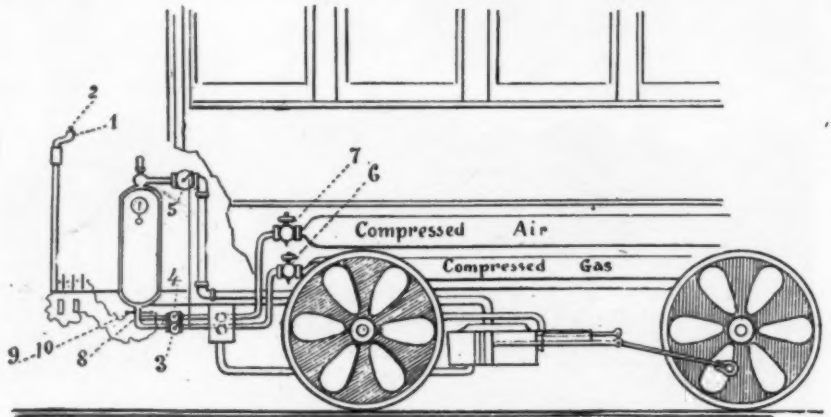


FIG. 2.—MOTOR CAR WITH GENERATOR IN POSITION.

an arrangement similar to that shown in Fig. 2 is employed. In order to start the car, the lever, 1, is gradually pulled forward, thus opening the gas-valve, 3, the air-valve, 4, and the throttle-valve, 5, simultaneously. The valves, 3 and 4, receive air and gas in proper proportions from their respective tanks through the pressure-reducing valves, 6 and 7. The explosive mixture, when it has reached the igniter, 8, is discharged by an electric spark between the terminals, 9 and 10. The spark is made to pass between the terminals by pressing the button, 2, simultaneously with the operation of the lever, 1. The motor, when started, pumps water to the steam generating coils in the combustion chamber of the generator. In order to stop the car, the lever, 1, is pushed backward, whereby the air, gas, and throttle-valves are simultaneously closed, and the motive agent cut off. In operating cars by means of this generator, a compressing station is required. But when the apparatus is used on horseless carriages, the compression station is dispensed with. The motor does its own compressing and delivers the air to a supply tank connected with the oil tank by means of a by-pass in order to have equal pressure in both tanks.

THE DESIGNING OF AUTOMATIC MACHINERY.*

By HANSON ROBINSON.

UNDER this head I will consider only those machines known primarily as labor-saving machines. The field for such machines being necessarily new, strange con-

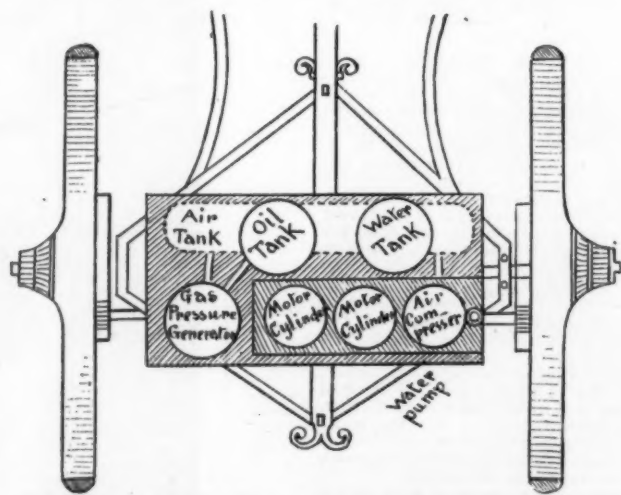


FIG. 3.—REAR END VIEW OF HORSELESS CARRIAGE.

ditions must usually be met, and seemingly insurmountable problems must often be solved.

Before beginning the work of designing such a machine, several questions should be thoroughly considered and answered, without which the success of the machine could in no way be assured.

The designer of automatic machinery must have peculiar gifts or qualities to be successful. First, he must be an inventor. By this term I mean a man who, when confronted by a seemingly insurmountable problem, must have the requisite originality of thought and design to think out new ways and processes of accomplishing a given object, thereby leaving the well-beaten

track. He must be able to look unbiased at the problem from all sides, and be competent to consider and weigh carefully the governing principles which affect the question in hand. Because every design of a machine, even the most successful one, is but the result of a compromise. Some features of construction have to be modified or changed to suit some other equally important part, and so it is to the end. He must be able to consider all the conditions together, discarding this part and modifying another, so as to obtain the best result as a whole. He must be imaginative. By this I mean he must be able to bring in general outline the machine with all its principal features before his mind's eye, and the problem should have been thoroughly thought out that he is able to do this after he has made his preliminary hand sketches, and before the drawing proper has been begun; because drawing is but the mechanical representation of the designer's thoughts. The thought has to be before

the drawing is made, and the clearer and more accurate the thought, so will be the drawing.

Coupled with these gifts must be a good, retentive memory that can recall different features or movements of a machine that may have been seen, at some previous time, and which can be brought in realistic survey before the mind's eye, so that the desirable part of such may be so modified as to suit the new conditions. This quality is also embraced by that very important gift, experience, without which the others are almost worthless. And I may add another talent, which is by no means the least, and that is accuracy, which not only applies to the making of the drawings, which is only mechanical, but accuracy of thought, which can usually only be obtained by long training.

Also be systematic in thinking out the design; don't jump from one operation to another, and thereby skip over or leave unfinished until the end some one part which appears at the time to be of a trivial character. Take up each consecutive operation in its own turn, and don't leave it until it has been completely thought out and arranged for; because these very same overlooked operations sometimes prove to be the most troublesome features of the work.

Therefore I will endeavor to present in a systematic order the following points to be considered, and which will be found applicable to any machine undertaken, and under these heads a correct classification of the various questions which may arise can be made. These heads are as follows, and will be taken up for consideration in regular order:

1. What is the machine intended to do?
 2. Do you thoroughly understand the several operations as they are now being done by hand?
 3. What has been previously done along this line?
 4. Under what conditions is the machine to be operated, and of what capacity, both mental and physical, are its operators?
- In taking up the first question, What is the machine intended to do? there should be a clear understanding and knowledge as to what use the product of the machine is to be put. How much uniformity in the product, regarding its accuracy of shape, size, and consistency, is required, and what is the limit of inaccuracy allowed?

What is the required output from the machine per day, and what is the capacity of the hand opera-

*A paper read at the December meeting of Baltimore Chapter, Association of American Draughtsmen.—The Practical Engineer.

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tors on similar work per day? Under this head one may include the cost of hand labor, and what saving can be expected by the use of the machine. This would also include the consideration of a rough estimate of the first cost of the machine, and about what number of machines would be required, thus showing in a general way whether the machine would be a commercial success, because if now it should appear doubtful, no more time and labor should be spent on it.

We now come to the second question, Do you thoroughly understand the several operations as they are now being done by hand?

It is, of course, self-evident that if there is only a partial understanding of how the operations are performed by hand, in all their details, no machine can be designed to accomplish the same result; and the only way to obtain this knowledge is to watch closely the hand operators on this or similar work. Then learn to do this work yourself, and thus obtain a thorough and accurate grasp of the subject. In this way you will also become intimately acquainted with the quality and texture of the substance. It may be tin, tobacco, iron, wood, or paper. Understand its physical properties—whether it is readily affected by atmospheric changes, by heat or cold, dryness or dampness; can the substance be obtained of such uniform character that when one lot has been run through the machine the subsequent lots will be all like it, or will certain portions of the machine have to be made adjustable to permit of variation in the substance?

After learning how to perform these operations yourself, you are in a position to analyze the several operations and resolve them into their simplest forms. The system or order in which these movements are made should also receive careful consideration; because by doing so a slight change in the order may result in simplifying the mechanism in the machine. For it should be remembered that the simplest movement of the hand, as in picking up a book and placing it in another position, would, if it be done by a machine, involve several complex motions, which would of themselves require a somewhat complicated machine.

In considering the third question, What has been previously done along this line? it should be borne in mind that there is nothing new under the sun. So the first thing to do is to draw on your own knowledge of what machines you have seen that could do any of the needed operations—what are their faults, and have they any advantages? Here is where experience and a good memory are strong allies, for, by passing before your mind what you have seen you are enabled to pick out this or that portion of some movement or train of mechanism which may be applicable to your present needs.

Then, to make use of Patent Office records, take those classes or sub-classes which bear on any portion of your problem, and you will be sure to obtain some information which will be valuable to you. After following this course of investigation you are in a position to consider more intimately the mechanical details of design. This, of course, would include the consideration in a general way of the maximum power which will be required to run the machine, the proper amount of gearing necessary, and the arrangement of the driving mechanism, and general outline of frame or housing and bedplate. Of course, after considering this part of the subject, a very good general idea is obtained, which will be a guide in proportioning the strength of the various parts of the machine. For instance, if a machine is to bend paper into a certain form or shape, and another machine is required to bend tin into the same shape as the paper, the strength of the machines and their integral parts, and the power required to run them, will vary greatly. In this way a very correct idea can be obtained, and if the subject has been gone over carefully and fully considered, the machine is in a fair way to being a success.

The fourth head, Under what conditions is the machine to be operated, and what is the mental and physical capacity of its operators?

This question brings us to the time when the machine is to be operated, and although this heading is the last, it is by no means the least in importance, because many a machine has been pronounced a failure because this very subject had never been considered. A machine may run satisfactorily when being watched over by a machinist, but if the machine is to be run by an ignorant if not malicious set of operators, the style of mechanism, and probably the whole design, may have to be altered to suit these conditions. If girls are to run the machines, levers and treadles and clutches and those parts to be moved by hand should be so proportioned as to be well within their strength. Any portion of the mechanism which is liable to be clogged by dirt or broken by the carelessness of the operator should be properly protected by means of guards and covers. There should be a ready access to all parts of the machine, so as to keep it clean and properly oiled. Those parts which the operator is allowed to take off and clean should be so made that there could be no mistake in placing them accurately.

Of course the machine should be so provided with guards over the gears and other dangerous parts as to thoroughly protect the operator.

In conclusion, I will say that after handling the subject in this manner, making full and ample experiments of any doubtful part of the mechanism and preliminary drawings to see how certain principal movements will work in, the designer will now have a thorough grasp of the machine to be designed, and if possessing the previously mentioned talent and requisite amount of experience, the proposed machine may confidently be expected to be a success.

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The amazing cheapness in late years of many articles made by machinery is one of the characteristic features of the evolution of manufacturing industries under modern methods. As a single illustration it may be mentioned that vendors on the business streets of all large American cities are selling for one cent each collar studs having porcelain backs and hinged shanks; and even at that price the studs are thoroughly well made. The extraordinary cheapness of the collar buttons can be readily explained. They are made by the million by special machinery, and are sold by the gross at a price which enables the jobber to supply them to the street merchants for less than ten cents a dozen.

THE "IDEAL" SAW-GUARD.

We illustrate a form of circular saw-guard recently introduced by Messrs. M. Glover & Company, Holbeck Lane, Leeds. The general arrangement of the device is well shown in Fig. 1, while the details of its construction will be easily gathered from Figs. 2 and 3.

A bracket, 1, bolted to the table serves to support a vertical rod, 3, which can be clamped in position by the hand-wheel, 4, and supports a universal carrying block, 2, to which the arm, 5, can be clamped in any desired position.

The guard proper is supported by this arm, and con-

15, the hood tilting about the center, 14, and the back blades about the centers, 22 and 23. Perforations are made in this hood, as shown at 16, in order to enable the sawyer to see the line of his saw. The usual adjustable fence is shown in position at 17. The loose plates giving access to the saw spindle bearings, etc., are shown at 20 and 21.

It will be seen that the hood of this guard protects the sides of the teeth, as well as the points, while the back guard is so firmly held laterally that it enters into the cut without having to be guided by hand, as is necessary with some guards in which this back blade is less efficiently supported. The makers supply

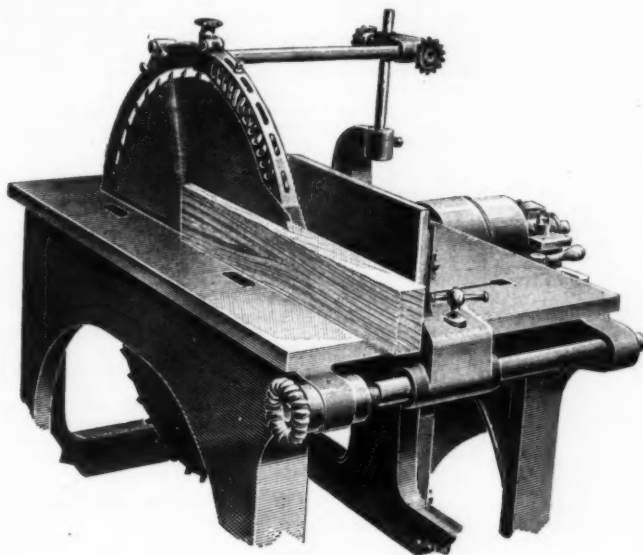
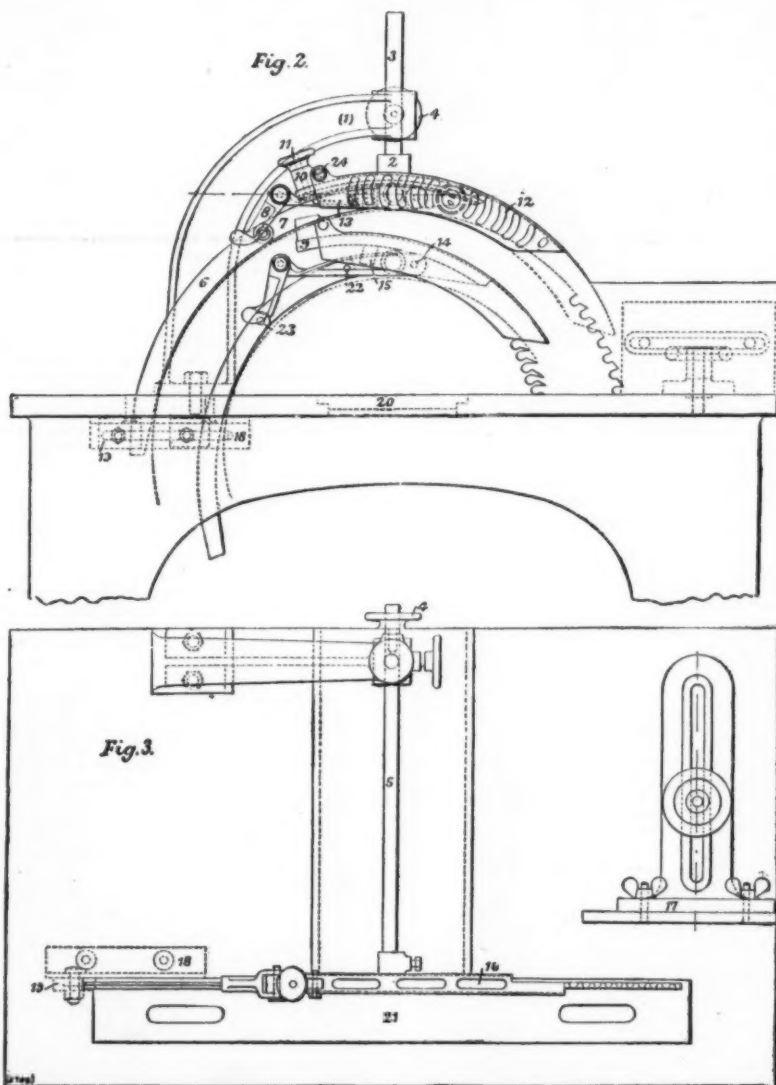


FIG. 1.



GUARD FOR CIRCULAR SAWS.

sists in the first place of a long, thin, curved, and hinged steel blade, which forms the rear guard, and is held in position by a sliding bolt and vice plates, 19, attaching it to the bracket, 18, below the table. A forked tailpiece, marked 8 in Fig. 2, keeps the hinged blades in line with the saw, and stiffens them against a side thrust. A tilting holder, 9, supports the hood, 12, in any position desired, and can be adjusted to accommodate different sized saws, as indicated in Fig. 2. A curved block, 10, works in the slide of the tilting holder, and can be clamped in position by the small hand-wheel, 11. The arrangements for adjusting the guard to different sized saws are figured, 13 and

these guides for all sizes of saw up to 48 inches in diameter. We are indebted to London Engineering for the engravings and article.

A Swedish officer who has lately returned to St. Petersburg after visiting the far East is of opinion that it will be at least five years before the Manchurian Railway is completed. It appears that there is a scarcity of labor, and also that the Chinese workmen, at present numbering about 12,000, are unable to work during the severe winter, which lasts from four to five months.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

United States Exports to Germany.—Those who read the German press cannot entertain the slightest doubt that German industrial circles look upon the enormous development of the industries of the United States, during the last few years with apprehension, says Louis Stern, commercial agent at Bamberg.

Several meetings of representatives of industrial branches have taken place in Germany within the last few days, and the main point of their discussions was, in every instance, the ever-growing exports of the United States.

The meeting of German manufacturers of tool-making machines which was held at Düsseldorf last week asks for protection against the increasing American importation; so does the convention of German shoe manufacturers, which took place at Breslau a few days ago. The association of German cycle manufacturers means to fight American competition even more keenly than the representatives of the branches just named. The agrarians, as is well known, would like to exclude American grain, meat, and fruit.

I am of the opinion that our exports to Germany will continue to increase, if we take the trouble to study the wants of these people; and, above all, if we maintain the quality of our goods.

Whoever enters a shoe store in Germany where American goods are to be had knows that he there gets the best, the most comfortable, and the most elegant shoes that are to be obtained; and, knowing this, he willingly pays a higher price than for the German article. To keep this reputation is of the highest importance to American exporters. One of the leading retail merchants of this city, who has branches in several towns of Bavaria, and who handles American articles, called my attention to some American shoes for ladies which retail at \$1.25. "If you want to kill your export trade to Germany, you must continue to sell such goods," he said. Quantities of cheap and unreliable American shoes thrown upon the German market would do endless harm to our exports in this article.

The same is true of machinery and tools, in which branches of manufacture our country stands unrivaled at the present day, and it applies with still more force to cycles. So far as I could ascertain, out of 2,100 cycles now in use at Bamberg, a quiet place of 40,000 inhabitants, about 60 are of American origin; but they represent the best that is made in our country, and the two local dealers who keep American machines tell me that the demand for them is very good, although the prices are higher than for the best native article. As in the boot and shoe trade, this reputation can be lost to us only by the exportation of cycles of inferior make. My attention was called the other day to an advertisement in the Frankfurter Zeitung, which read as follows: "One hundred American cycles to be sold at any price." Soon afterward, a local dealer in German bicycles put in an advertisement in which his machines were represented as "good, cheap, and reliable," compared with the "poor American make." The result of my inquiries was that there were no American bicycles of inferior quality to be had, and that one had never been sold at this place. This insignificant incident shows how anxious people are to lower the reputation of the excellent American wheels. It lies entirely in the hands of our export firms to make such efforts unsuccessful, by withholding inferior goods from the German market.

The way to introduce articles into Germany has often been pointed out to the interested parties, viz., send experienced representatives, familiar with the customs and language of this country, establish sample stores, and prepare catalogues giving necessary details in German. The latter point cannot be repeated often enough, for the numerous pamphlets and catalogues in English received at the consulates day by day are of no use whatever for German business. Upon my endeavoring the other day to demonstrate the advantages of American tool-making machines to a local firm (Buxbaum Brothers), one of the most important in this part of Bavaria, by means of a catalogue printed in English, I was told that the firm had no time for translations. At the same time, the manager showed me the catalogue of an American manufacturer of agricultural machinery, beautifully prepared, translated into German, brief and to the point; the machines (reapers and mowers) of the firm are to be found in this part of the country by the score. He said: "Our agents always carry these catalogues with them, and they can be found among the best classes of the peasantry."

At the present time, when the German machine industry is so busy that people have, in many cases, to wait twelve months for machines that have been ordered, our manufacturers should gain a firm footing on the German market. It can be done by sending the proper men over, by conforming to the German usage of giving credit, and by carrying out orders promptly and well.

Efforts to Increase German Exports.—Vice-Consul General Hanauer, of Frankfurt, under date of June 9, 1899, sends translation of an extract from the Berlin Confectionair, one of the principal organs of the German manufacturing and export trade, especially in such lines as textile goods, ready-made clothing, etc. The German people, adds Mr. Hanauer, are fully alive to the importance of not only maintaining their present position as purveyors to the world's market, but believe it essential to their standing as a "great power" to make still greater efforts to compete with England, which heretofore had the lead, and with new and energetic rivals, such as Belgium, Japan, and, last but not least, the United States. The extract reads, in part:

"WHAT DOES GERMANY DO FOR HER EXPORT TRADE?"

"Of late, from various sides, demands have arisen for the establishment of a central bureau, on the order of a commercial museum, like that in Philadelphia, in order to further Germany's export trade. In view of the mighty efforts which other nations are making to push Germany from the position which she has won in the world's markets, it seems necessary for our government to use all methods which other nations employ in competing with us. It is a stale truth that hitherto the Imperial government has done very little in this line.

"It is a gratifying change, auguring better results for the needs of our commerce, that considerations are pending to improve our consular system, and the fact that the modest item of 55,000 marks (\$13,000) appears in this year's budget of the Foreign Office, to be expended in sending commercial experts abroad, is further evidence that this government is beginning to use those methods which have in the past been so successfully employed by England, France, and the United States in fostering their foreign trade.

"We have a numerous staff of consuls, who promptly and regularly send in their reports, but no one can maintain that these meet the wants of trade. It is a fact long since admitted that the immense mass of information stored up in the monthly publications Handels-Archiv has no direct or practical value to our merchants. How inferior our consular system is to that of other countries is evidenced by the fact that Germany has only five professional consuls in the United States, whereas the latter country is represented by eleven salaried consuls in the Rhenish province of Prussia alone. The institution of chambers of commerce outside of our own country is new to us. Austria, England, France, the United States, Holland, Spain, Italy, and Belgium have these in foreign lands, and even Greece and Turkey are about to establish them.

"It is true that our export trade is at present in such good shape that the resort to extraordinary means for its improvement might seem prompted by excessive anxiety; yet we must bear in mind that the growth of our foreign trade does not keep step with the increase of our domestic production.

"It has become generally known that while bloody contests between nations are of less frequent occurrence than of yore, struggles in economic fields are gaining in acrimony, internal trade is becoming more complicated, and the constantly growing competition makes it necessary for us to leave no means untried whereby we may not only maintain our present prominent position in the world's trade, but secure it in the future."

Broom Factory in the Transvaal.—Consul Macrum, of Pretoria, under date of June 24, 1899, sends translation of a concession by which the government of the South African Republic grants to Messrs. Gottstein & Lagesen certain rights and privileges in the manufacture of brushes and brooms. The consul adds that he understands that Mr. Gottstein is about to depart for the United States in quest of capital, machinery, material, etc. The substance of the concession is given below.

The government gives the contractors the right to manufacture all kinds of brushes and brooms, made of hair, plants, fiber, etc., as well as painters' and all other sorts of brushes. The place of erection is to be specified by the government, and the construction of the factory is to be begun within twelve months. The contractors are to use, as far as possible, the raw produce of the republic. The products shall not be sold at a higher price than the fluctuating market prices of the South African Republic, the additional special duty not being included. If the products of the factory are of a quality and quantity to satisfy the government, a special prohibitive duty of 33½ per cent. will be granted by the Volksraad. After the first three years, the government is to receive 5 per cent. of the net profits accruing from the above-named factory, this payment to be made yearly. Government officers shall inspect the books of the factory from time to time and exercise control of the working.

Nonfulfillment of the contract will involve a fine and revocation of the concession. Disagreements shall be decided by arbitration, a final umpire (in case of necessity) to be chosen by the high court of justice of the South African Republic.

The contractors have the right to form a company. This agreement shall last thirty years and may be renewed under like conditions for a further period of thirty years.

Trade Conditions in Persia.—Under the caption "Germany's Trade with Persia," a writer in a leading Chemnitz paper points out this empire's position in that country, says Consul J. C. Monaghan, of Chemnitz. He says, among other things, that Germany is very poorly represented in Persia. In the northern part of the Shah's dominions are no German houses at all. In the south, quite recently, a German company had made business connections, but as yet to little or no purpose; since to do business in Persia a knowledge of language, customs, and habits of the people is absolutely necessary. The imports, which, by the way, are very considerable, are almost entirely in England's hands.

Persia, says the writer, who has lived eighteen years in Shiraz, is not very rich. The population is made up, for the most part, of nomadic tribes that move from one grazing place to another. In the midst of these vast grazing tracts are the larger cities. In Teheran, the capital, one finds the richer classes. Bushire and Bender Abbas are ports where goods enter for transmission to the interior by means of caravans. The carrying is done by mules and camels. Roads and means of transportation are very primitive, but it very seldom happens that a caravan is robbed. Commerce is active. The imports are sugar in boxes and bags, candles, iron, cloths, cotton goods, iron wares, stone wares, copper, tea, indigo, leather, articles of luxury, etc. In articles of luxury, the prospects for a large business are excellent.

To establish one's self in Persia, a large capital is almost indispensable. One needs from \$40,000 to \$50,000. The Persian does not pay cash. He never wants less than three months' credit. To sell on such long time, one should have considerable local information. It is hard to get facts as to a firm's or merchant's standing. Sales for cash are possible only when very small quantities are disposed of—when the supply is small and the demand large. Money in Persia pays from 12 to 18 per cent., and merchants seldom if ever do business on a basis that pays less. Europeans are always ready to sell, since 6 per cent. is the best they can expect at home, and credit sales pay well. It takes two and one-half to three months for goods to arrive in the interior of Persia after they leave London. Thus, the goods are two months in transit, are sold on three months' time, and before the merchant in London gets his money, seven or eight months have passed.

German houses, says this merchant of Shiraz, shrink from sales when the Persian merchant puts his time of payment months ahead. Because of this, business is very seldom done by German houses. Besides, Germans, who have no good representative in Persia, run great risks. Their hesitation to hand over goods to unknown parties is reasonable. Business, therefore, with all its profits, remains in English hands. Another point to be carefully considered by parties desiring to do business in Persia is that a house must have everything on hand from a button to a big Krupp gun.

Russia is rapidly rising to a very important place in trade, especially in central Persia. The Russians, however, do not come themselves, but are represented by Persians or Armenians. They sell large quantities of Russian glass and stone ware. In these lines, they have no competitors—first because the importation via Bagdad, because of Turkish tolls, is too expensive, and, second, because the goods come from the neighboring Russian frontier provinces and meet Persian needs. For instance, samovars, cheap mirrors or looking-glasses, drinking-glasses, etc., are sold. German merchants might do a very large business in beet sugar, since it is preferred to the English and Russian. Up to date, France has furnished this article (beet sugar).

England is engaged in an effort to obtain better roads. The English consul in Isfahan demanded, in his last report, the intervention of his government to get the Persian government to do something in the line of roads, and his efforts were successful. South and West Persia have no roads; North Persia, only two. Of these the one from Isfahan to Rescht was built by Russians. A road is being built between the capital and Ahwaz. This will run down to the Persian Gulf and cheapen freight rates to the interior. In spite of every obstacle and difficulty, England's exports to the Persian Empire are increasing.

United States exporters may perhaps profit by these suggestions. We might send cheap cottons, sugar, candles, iron, ironware, stoneware, copper, leather, and fancy articles.

German Schools in Foreign Parts.—Consul Monaghan sends the following from Chemnitz, June 3, 1899:

It may not be generally known that Germany maintains schools in foreign countries. A fund is yearly voted by the Reichstag for this purpose. There is now an agitation in favor of granting the schools the right to award exemption from the long periods of military service; in other words, to grant the one year service diplomas. It is argued that when young men in foreign parts, born of German parents, can pass examinations and earn the right to serve in the army only one year, they will have greater inducement to retain their German citizenship. It is pointed out that boys born abroad, deprived of this right, go into other armies, and necessarily assume citizenship of the state under whose flag they stand. These facts have had great weight with the government. The efforts of this people in foreign countries not only in selling the products of its industry, but in propagating its language and maintaining its hold on its offspring, are untiring.

American-Asiatic Association of Japan.—The department has received from Consul-General Govey, under date of Yokohama, June 27, 1899, a report of the organization in that city of a society of American citizens under the above title. The constitution adopted sets forth the following as the objects of the association:

"To foster and safeguard the commercial and other interests of citizens of the United States of America in Japan."

"To promote a beneficial acquaintance and association among Americans in Japan, and by union and permanent organization to give more effective aid in behalf of measures intended to advance such interests."

"To gather and distribute information of importance to its members."

"To act in concert with, and aid in the purposes of, the American-Asiatic Association of New York and the American Association of China, and such kindred associations as may hereafter be formed in the Orient."

Any American citizen of full age, resident or temporarily residing in Japan, is to be eligible to membership. The annual dues are to be 10 yen (\$4.98), payable annually in advance on the 1st day of July in each year. There will be an annual meeting of the association in the city of Yokohama during the month of October in each year.

Failures of Norwegian Paper Mills.—Consul Bordewich, of Christiania, under date of June 26, 1899, informs the department of recent failures in that city. Five of the largest manufacturers of paper and cellulose have failed, and the value of nearly all classes of stock has declined.

The Norwegian output of wood pulp, adds the consul, will in all probability be reduced for some time to come.

Demand for Automatic Lawn Mowers and Incubators.—Consul Lebert writes from Ghent, July 25, 1899:

I have this day received a request from Dutry-Cobson, No. 13 rue des Champs, of this city, for the names and addresses of manufacturers of automatic lawn mowers and of incubators. This firm is one of the oldest, most reliable, and largest general hardware and machinery houses in this consular district. They request immediate replies, as they are now holding orders for such goods.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

- No. 514, August 28.—Japanese Regulations Relating to Foreigners.—Operation of Japanese Treaties.
- No. 515, August 29.—Canadian Competition in Great Britain.
- No. 516, August 30.—Proposed Port at Montevideo.
- No. 517, August 31.—United States Fruit and Fruit Waste in Germany.—American Fruits in the Orient.—American Candy in South Africa.—Boots and Shoes in Lourenco Marques.
- No. 518, September 1.—Electric Street Car System of Hamburg.—Notes from Dawson City.
- No. 519, September 2.—Provisional Customs Regulations of Kyocuan.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Production of Clear Zinc Chloride Solutions.—To obtain clear zinc chloride solutions without precipitate, Wiskirchen recommends to dissolve the zinc chloride only in boiling hot water, and to make dilution with warm water only. This goes to show that zinc chloride solutions can be produced without any admixture of hydrochloric acid.—*Neueste Erfindungen und Erfahrungen.*

Black Mustard Flour for Ridding Empty Bottles of Bad Odors.—In order to render bottles and vessels in which strongly smelling liquids, alcohol, rum, etc., have been kept perfectly odorless and clean, so that they may be used for the finest wine, etc., powdered black mustard seed is successfully employed. Pour a little of it with some lukewarm water into the receptacle, rinsing it afterward with water. If necessary, repeat the process.—*Schettler's Sonntagsblatt.*

According to the Werkstatt, cement for broken cast iron articles is prepared as follows: Take sal-ammoniac 2 parts, sublimated sulphur 1 part, and cast iron filings 16 parts; mix the ingredients in a mortar, and keep this powder perfectly dry. When it is to be used, mix it with 20 times its weight of clean iron filings, crush all in the mortar, and wet it with water, till it turns into a paste, with which the fractures are coated, pressing the object together. After a while the cemented places become as strong and hard as the other metal parts.

P. Wolff states that the method of purifying acetylene proposed by Frank gives good results. It consists in the use of acid solutions of certain metallic salts, particularly copper chloride, and results in the transformation of part of the acetylene into aldehyde. It is claimed that one liter of the solution employed will purify 14 cubic meters of acetylene, and that the liquid can be regenerated by boiling, followed by aeration. As an alternative process the use of chlorinated lime containing a small quantity of an alkaline chromate is proposed. In this method the free chlorine is absorbed, and the acetylene does not undergo any decomposition.—*Jour. für Gasbeleuchtung, through Chem. News, 80, 40.*

Apollo Illuminating Oil.—The fuel oil obtained in large quantities as waste in alcohol distilleries, and purchasable at a low price, is washed with milk of lime, mixing 100 kilos of fuel oil with 15 kilos of milk of lime in a vat, whereby the oil, which possesses a yellowish to brown color, is completely decolorized and the fat substances contained therein are decomposed. Now add to 100 kilos of the fuel oil 25 kilos of petroleum, mixing intimately and leaving alone for 24 hours. When, after 24 hours of storing, the milk of lime has separated in the form of scales, it is drawn off. This cheaply produced lamp-oil has the characteristic of burning without a glass chimney, with a perfectly smokeless and odorless bright flame, with very slight consumption of oil.—*Seifensieder Zeitung.*

Blackening Art Forgings.—The blackened articles are not only very pretty, but the process also protects the iron from rust for a long time. According to the *Zeitschrift für Maschinenbau und Schlosserei*, the treatment is very simple. It consists in coating the objects very uniformly with a thin layer of linseed oil varnish, and burning it off over a charcoal fire. During the deflagration the draught must be stopped. The varnish will first go up in smoke with a strong formation of soot, and finally burn up entirely. The process is repeated, i. e., after one coating is burned off a new one is applied, until the parts exhibit a uniformly handsome, deep black color. Next, wipe off the covering with a dry rag, and heat again, but only moderately. Finally, the articles are taken from the fire and rubbed with a rag well saturated with linseed oil varnish. The black turns completely dull, and forms a real durable covering for the objects.

Removing Broken-off Pieces of Steel from Other Metals.—By M. Bornhäuser, of Charlottenburg. The removal of broken-off spiral drills and taps is an operation which even the most skillful machinist has to perform at times. If the piece has little value, it is usually thrown away, but in the case of more valuable objects, it should always be attempted to obviate the damage.

A practical process for removing such broken steel pieces consists in simply preparing in a suitable kettle (not iron) a solution of 1 part, by weight, of commercial alum in 4 to 5 parts, by weight, of water and boiling the object in this solution until the piece which is stuck works itself out. Care must be taken to place the piece in such a position that the evolving gas bubbles may rise and not adhere to the steel to protect it from the action of the alum solution.

The author has conducted numerous tests with this process, and the final experience has been that the alum solution is a valuable means by the use of which many a workpiece can be preserved which would otherwise be lost.—*Deutsche Mechaniker Zeitung.*

Production of Opaque Paper.—Soluble compounds of calcium, barium, or lead are mixed as intimately as possible with the fibers of the paper, and through suitable admixture by means of double decomposition in soluble compounds of the said elements are precipitated on the fiber.

If the paper is sized in the pulp, the precipitating is done in the rag-engine before the sizing. In the case of superficial sizing, the partly dried unsized paper should successively be drawn through baths of the soluble salt and the precipitant.

As an example, the following directions for thin letter paper are given:

To 150 kilos of paper stuff 45 kilos of commercial soluble soda glass are entered in the rag-engine; two hours before emptying, and after thorough intermixing, 26 kilos of calcium chloride solution is added. Next, the stuff is treated in the usual manner, while one has to see to it, by adding a sufficient quantity of aluminum sulphate (2½ kilos in the case described), that the stuff has the acid reaction necessary for good sizing.

The resulting calcium silicate renders the paper opaque and is also said to increase its whiteness. The mutual decomposition of sugar of lead with aluminum sulphate, from which lead sulphate remains among the fiber, is said to give equally good results, but is prohibitive owing to the poisonousness of the lead compounds.—*Neueste Erfindungen und Erfahrungen.*

MISCELLANEOUS NOTES.

Some interesting details have lately been published as to the character and extent of the resources for the production of iron and steel in Germany. It appears that at a recent date there were 672 iron mines in the empire, of which 496 were exclusively devoted to iron mining, while 32 others mined iron ores as an accessory product. At the same date there were 154 mines not in operation, of which 96 were in process of being opened.—*Engineering and Mining Journal.*

We learn from Tunis that the Compagnie des Phosphates et du Chemin de Fer de Gafsa, a corporation engaged in extensive enterprises in that protectorate, is in the market for all sorts of rolling stock, including locomotives, and that proposals have already been invited in this country. The address of the company is 60 Rue de la Victoire, Paris, and for cabling purposes it may be addressed as the "Compagnie Gafsa."—*Commercial Intelligence.*

The report of the engineer in charge gives the total freight passing through the Sault Ste. Marie Canal from the opening of navigation up to July 31 at 10,433,875 short tons, which compares with 9,568,599 tons in 1898, and 7,872,695 tons in 1897. The number of vessels reported this year was 8,599. Of the freight this year, 8,547,807 tons were east bound and 1,886,268 tons west bound. The mineral freights included 6,474,735 tons iron ore (5,778,123 tons in 1898); 392,523 tons anthracite coal (193,535 tons in 1898); 1,227,038 tons bituminous coal (1,630,568 tons in 1898); 45,343 tons copper (62,246 tons in 1898). The falling off in copper was due to the fact that considerable shipments were made by rail before the opening of navigation, owing to the unusual pressure for early deliveries.—*Engineering and Mining Journal.*

The Camps of Concentration in the United States during the recent war signally demonstrated the greater dependence of disease upon neglected local conditions than upon climate. Of the total number, 6,209 deaths, reported at the end of the war, 45 occurred in Honolulu, 287 in Porto Rico, 606 in the Philippines, 1,399 in Cuba, and 3,873 in the camps of concentration in the United States. Typhoid fever and other intestinal diseases traceable to befoiled water and filthy soil roundabout were the chief causes of mortality, and upon this knowledge it was suggested by some army officers and others that the government should establish and maintain a number of permanent sanitary camps in various sections of the country, such camps to be properly sewered and provided with pure water, and kept in condition for occupancy at a moment's notice, in anticipation of future emergencies.—*The Sanitarian.*

A rather interesting subject was discussed at the recent meeting of the American Society of Civil Engineers, and related to the protection of overhead bridges from gases emitted from locomotives. The discussion called out a number of interesting remarks concerning the practice of erecting such bridges and putting upon them no other protection from the effects of gases than a coat of paint. Bridges are being erected in large numbers, and still apparently the attention paid to this matter has been very slight. The engineer builds not only for the present, but for the future also. If he is inclined to look ahead, and realizes that his work in the course of a few years will need repair and perhaps renewal, it does seem that something should be done by him to prevent damage being done in the manner suggested. Prevention is better than cure in most cases. Paint is of no use at all when attacked by locomotive gases. Bridges have been constructed with wooden ceilings, which ceilings have completely protected the steelwork from the action of locomotive gases.

The Montana State Penitentiary, a handsome brick and stone building, capable of accommodating five hundred prisoners and said to be one of the finest buildings of the kind in the country, has a somewhat novel history. The work, which would have cost at least a quarter of a million, was done by the inmates of the prison within a space of four years, at a cost of only about \$50,000. With the exception of the superintendent, the foreman of the brickyard and the tinner who had charge of the covering of the roof, all the work was done by "criminals," many of them unskilled laborers. Even the architect who furnished the design for the building was a prisoner whose sentence expired only a few weeks prior to the commencement of the construction. There were no quarrels among the men, no insubordination and no attempted escapes while the work was in progress. Without chains or fetters and with few guards, the men quarried the rock, cut and dressed the granite blocks, moulded and burned the bricks, dug the sand, burned the lime, cut the logs and sawed the timber.—*Boston Transcript.*

The holding power of anchor bolts has been made the subject of some tests by Mr. M. M. Wilcox, who summarizes results in a paper published in the *Technograph* of the University of Illinois. These experiments were made upon the holding power of bolts fastened with cement, lead, and sulphur. Holes 1½ inch to 1½ inch in diameter were drilled in hard limestone blocks about 6 inches thick. About one-half of the bolts were 1 inch in diameter, and the others were ¾ inch in diameter. Smooth, threaded, and notched bolts were used. The smooth and notched rods, always drew out of the cementing material; the threaded bolts sometimes drew out of the lead and sometimes pulled the lead out of the hole, and always pulled out the cement and sulphur. A good cement was mixed to a grout or plastic mortar, and rammed around the rods. After standing for seven days the mean of twelve experiments with smooth bolts gave a resistance to pulling of 106 lb. per square inch of surface of contact of bolt. Three experiments with notched rods gave a mean result after seven days of 336 lb. per square inch, two threaded rods gave 585 lb. per square inch after seven days, and two gave 832 lb. per square inch at the end of fourteen days. With lead four smooth rods gave 332 lb., one notched rod gave 460 lb., and six threaded rods gave 903 lb. per square inch. With sulphur the threaded rods gave a resistance of 1,502 lb. per square inch, a mean of seven experiments, one notched rod gave 328 lb., and one smooth rod 200 lb. per square inch.

SELECTED FORMULÆ.

Removing Silver Stains.—The following solution will remove silver stains from the hands and also from woolen, linen, or cotton goods:

Mercuric chloride.....	1
Ammonia muriate.....	1
Water.....	8

We do not advise the indiscriminate sale of this solution, owing to its very poisonous character.—*American Druggist.*

Bay Rum.—Bay rum is, as most pharmacists are aware, distilled in the West Indies from the fresh leaves of the *Myrcia acris* and allied plants. The United States Pharmacopœia contains a formula for a bay rum made another way and does not recognize the West Indian product, the change from the distilled to the manufactured article having been made by the committee which revised the Pharmacopœia of 1870 (fifth) and published that of 1880 (sixth).

Both before and since the pharmacopœial change numerous formulas for making bay rum have been devised, some of which are here given:

1. Oil of bay.....	1 ounce.
Oil of orange peel.....	½ drachm.
Alcohol.....	76 ounces.

This is based upon the pharmacopœial formula, with the oil of pimenta omitted.

2. In his treatise on the manufacture of perfumes, Snively gives this formula for bay rum:

Bay leaf otto.....	½ ounce.
Magnesium carbonate.....	1½
Jamaica rum.....	2 pints.
Alcohol.....	3
Water.....	3

Triturate the otto with the magnesium carbonate, gradually adding the other ingredients, previously mixed, and filter. If the rum employed contains sufficient sugar or mucilaginous matter to cause any stickiness to be felt on the skin, rectification will be necessary.

3. Oil of bay.....	38 minims.
Oil of pimento.....	10 "
Acetic ether.....	75 "
Tincture of orris.....	2 drachms.
New England rum.....	4 ounces.
Alcohol.....	1 pint.
Water, sufficient to make.....	2

—*Druggists' Circular.*

Toilet Cream.

1. Quince seed.....	2½ ounces.
Boric acid.....	80 grains.
Carbolic acid.....	1 fl. drachm.
Tincture of benzoin.....	12 fl. drachms.
Glycerin.....	6 fl. ounces.
Extract lilac.....	2 fl. drachms.
Water enough to make.....	64 fl. ounces.

Pour 32 fluid ounces of boiling water upon the seed, add the two acids, macerate for several hours, stirring occasionally, decant the liquid, upon the residue pour 16 fluid ounces of boiling water, macerate again as before, decant, mix and strain the two liquids, add the glycerin, incorporate the tincture gradually with vigorous agitation, add the perfume, and finally the remainder of the water.

2. Gum tragacanth.....	3 ounces.
Hot water.....	144 "
Potassium chlorate.....	6 "
Glycerin.....	48 fl. ounces.
Oil rosemary.....	½ fl. drachm.
Oil cassia.....	10 drops.
Oil rose geranium.....	5 "
Cedronian ether.....	5 "
Eloganth spirit.....	3 ounces.

WITCH HAZEL CREAM.

Quince seed.....	4 ounces.
Hot water.....	16 "
Glycerin.....	32 fl. ounces.
Distilled extract of witch hazel.....	128
Boric acid.....	6 ounces.
Tincture of rose.....	2 "
Violet essence.....	1 "

Macerate the quince seed in the hot water; add the glycerin and distilled extract of witch hazel in which the boric acid has been previously dissolved; let the mixture stand for two days, stirring occasionally; strain and add the perfume.

Filling for Dry Battery.—The following formula is said to yield a serviceable filling for dry batteries:

Charcoal.....	3 ounces.
Graphite.....	1 "
Manganese dioxide.....	3 "
Calcium hydrate.....	1 "
Arsenic acid.....	1 "
Glucose mixed with dextrin or starch.....	1 "

Intimately mix, and then work into a paste of proper consistency with a saturated solution of sodium and ammonium chlorides containing one-tenth of its volume of a mercury bichloride solution and an equal volume of hydrochloric acid. Add the fluid gradually, and well work up the mass.—*Pharmaceutical Era.*

White ink consists usually of finely levigated zinc carbonate suspended in mucilage of acacia, though other mixtures are used, notably a solution of either oxalic or hydrochloric acid in water. The latter affect the coloring material in the paper, where an ultramarine or deep blue paper is to be marked. The simplest form of white ink for use with any variety of dark colored paper is that which provides for the use of a white pigment like zinc carbonate, or a mixture of the latter and white precipitate as given below. The formula:

Zinc white.....	2 drachms.
White precipitate.....	5 grains.
Mucilage of acacia.....	1 drachm.
Water.....	6

Triturate the zinc white and the precipitate with 2 drachms of water until perfectly smooth, then add the mucilage and the rest of the water. The ink requires shaking from time to time to prevent the pigments from settling in a solid mass at the bottom.—*American Druggist.*

THE VICTORIA REGIA.

THE queen of water lilies, the *Victoria regia*, is a native of tropical South America, growing in the quiet bays of the rivers. As will be seen from our engraving (for which we are indebted to the *Illustrirte Welt*), it is similar to our white nymphaea, but attains such enormous size that its round leaves often have a diameter of seven or eight feet. The prickly undersides of these leaves are provided with numerous strong ribs containing many air cells which enable them to sustain a considerable weight, and as the edges of the leaves are turned up a distance of three inches, they certainly resemble trays or water-platters (irupe), as they are called in Guiana. In some parts of South

of the article are being described from time to time in *The Kew Bulletin* (see *American Journal of Pharmacy*, April, 1876) and *Notizblatt des Königl. Bot. Gart. u. Mus. zu Berlin*. According to Consular Reports, May, 1898, p. 73, the imports of rubber into the United States during the fiscal year 1897 were: Rubber, free of duty, 35,574,449 pounds, valued at \$17,457,976; rubber, dutiable, \$297,953; old scrap and refuse for manufacture, 3,658,945 pounds, valued at \$113,722.

The United States Pharmacopoeia recognizes the product of various species of *Hevea*, which is known as Para rubber. The State of Para does not produce (ibid., January, 1899) more than two-thirds of the rubber shipped through this port, the balance coming from the States of the Amazon as well as from Peru,

giving attention to the cultivation of rubber. Ecuador produces, it is said, every known species of rubber tree in great abundance, from the *Ficus dolairia*, in the vulgar Ragasron, to the *Urceola*, the most beautiful of all; the same can be said of Colombia. In these two countries the cultivation of rubber is a new industry. Hitherto, rubber has been obtained from wild trees, but the ruthless destruction of the plants by the greedy rubber seekers, who do not hesitate to cut them down to obtain a trifle more gum, has played havoc with the trade of this coast. In the remote regions of Ecuador there are still large forests, but inefficient transportation increases the cost. An effort is being made to obtain from the government an eight-year concession for the exploitation of rubber and quinine in a terri-



VICTORIA REGIA IN THE BOTANICAL GARDEN IN WASHINGTON.

America the plant is called the "water-maize" because the seeds are eaten by the natives. The *Victoria regia* is cultivated in hothouses in colder climates.

NATURAL AND ARTIFICIAL RUBBER.

Of all the plant constituents there are none of such great economic importance as those that constitute what is called rubber. This is the product contained in the milk vessels of the plants of a number of natural orders, viz.: Euphorbiaceae, Apocynaceae, Asclepiadaceae, Urticaceae, Lobeliaceae, and Compositae. These milk vessels were, according to Otto Chinani, first observed by Theophrastus and M. Lister, and first anatomically studied by Malpighi. A large number of species yield the commercial rubber, and new sources

Bolivia, etc. There entered the port of Para during the fiscal year 1897-98, 22,257 tons of rubber, and of this amount 11,422 tons were shipped to the United States and 10,796 to Europe.

The principal bearing areas in the State of Para are: The islands in the river Amazon, near the city; the banks of the river Tocantins; the banks of the rivers Xingu, Jary, and Tapajós. The upper and lower districts of the Amazon produce the same kind of rubber, but that coming from the upper rivers obtains a slightly higher price, being drier by the time it reaches the port of shipment.

It appears that the rubber-producing area in this Amazon section, recently discovered and untouched, is hundreds of times larger than that worked heretofore. Some of the South American countries are seriously

tory covering from eight to ten square leagues in the Province of Tungurahua.

Manicoba rubber from Ceara, Rio Grande, and Parahyba, States in Northern Brazil, ranks in price second to the Seringueira or Para rubber, and is preferred even in certain classes of work to the latter. The interest in the growth of the plant yielding this rubber is steadily increasing, not only in the three States mentioned, but is also extending rapidly throughout Pernambuco, Alagoas, and Bahia, as it seems to give better results with less labor than almost any other agricultural product. The way the greater part of the Manicoba rubber is produced is to simply cut the bark of the tree, letting the sap run in drops to the base, where by the action of the sun's rays it coagulates and forms an irregular, solid mass, which is gathered by

the natives and sold to middlemen, by whom it is shipped to America and Europe.

Mangabeira rubber is produced in the States yielding Manicoba rubber and Sao Paulo. The rubber appears to be an inferior grade, and is used for covering cables, etc. During the past six months (ending December, 1898) several consignments of Mangabeira rubber arrived in Santos from the interior and were quietly shipped to Europe. Formerly Mangabeira rubber brought only about half as much as that of Para, but the price has risen. It is said to be much harder and therefore preferable for certain purposes.

Florida rubber is a product that cannot be thought of for some time. It is true that the climate is admirably adapted for the cultivation of this tree, as suggested in Consular Reports, May, 1898. The writer also mentions that the camphor tree may also be grown here. While it has been demonstrated that the trees may be grown in Florida, the greatest item for consideration in this connection is the price of labor. So long as laborers who might collect these products are paid the relatively high wages they receive, the cultivation of these plants for their products cannot be looked upon in this country as being a financial success that is within immediate reach. In this country as well as elsewhere various attempts have been made to manufacture rubber artificially. A patent was taken out some time ago in Germany for making an imitation hard rubber out of sawdust. Another process for making substances resembling rubber was to treat fixed oils mixed with tar or similar distillate products with nitric acid. By interacting between various proportions of nitro-cellulose and bromo-nitro-toluol or nitro-cumol and its homologues, a material resembling rubber, it is said, may be obtained. Upon mixing a glue paste with tungstate of soda, the precipitate is

um. The more refined uses to which rubber is put, however, will still be a closed field, for the composition of corn rubber will prevent its substitution for India-rubber for scientific uses.

It is further stated that the new product may be advantageously mixed with Para rubber, producing a cheaper article of substantially the same quality for ordinary service as the genuine rubber.

The manifold uses to which rubber may be applied lead us to believe that we are likely to hear of the discovery of new plants yielding this product, the cultivation of the most important species, and many attempts in the manufacture of an artificial product.—American Pharmaceutical Journal.

ARCHÆOLOGICAL DISCOVERIES AT CARTHAGE.—I.

It is not without a certain feeling of awakened curiosity that we behold the vestiges of an entire vanished civilization coming to light after thousands of years; and at the sight of them we are made to live again in the past, and to wonder at the art of the ancients.

The excavations made by M. Gauckler have been very fortunate, and to this eminent archaeologist we are under many obligations. We desire on the present occasion to give simply a brief account of what has been found by him in the sanctuary of Jupiter Ammon; while in a second article we shall present a succinct

fishermen are seen handling the scoop and the lines, casting the net and harpooning poulps with the trident. At the lower part of the picture there are grouped various mythologic scenes. Amphitrite, bedecked with jewels, is contemplating herself in a mirror; and is coming out of a huge shell which is held by two monsters of the deep. On each side there are medallions representing, in half length bust, a male and female triton blowing conches. The second mosaic is smaller and represents a hunt for ferocious animals. From the style and drawing, we can hardly assign these pavements to a period remoter than the fourth century. They are mosaics of the Christian epoch. There is one, however, of which the subject is of purely pagan inspiration. The reason of this is simple: After the two mosaics had been taken up and carried to the Museum of Bardo, it was found that they concealed structures that were more ancient and entirely covered with rubbish. Upon removing the latter, there were perceived a narrow passage and the steps of a stairway. Upon descending these, a very remarkable hall was discovered. The debris of painted and moulded stuccoes covered the floor, and breccias were methodically grouped upon the walls. The dimensions of this hall had doubtless been subsequently diminished by dividing it through the middle by means of a wall. On the other side of the latter there were collected debris of every nature—Christian lamps of the fish, palm, and cross types, and fragments of pillars and stuccoes



FIG. 1.—HEAD OF THE STATUE OF CERES.

said to form an elastic mass under certain conditions. The latest artificial product is a corn rubber which is obtained, according to Chicago Times through Journal Franklin Institute, 1899, p. 251, from the refuse materials of the glucose factories. The following details will be of interest:

"Corn rubber has almost exactly the appearance of the ordinary reddish-brown India-rubber. The process of manufacturing is not perfect enough, however, to make it resist heat as well as India-rubber. This has offered the greatest difficulties to the chemists, who are now working to remedy this defect. The oil of corn, from which principally the rubber is made by some secret process, does not oxidize readily, and those who are working on the corn rubber declare this will be an enormous advantage for the new product. Articles manufactured from it will always remain pliable and not crack. Contrary to reports, this new product has not yet been put on the market. It is intended to go on with its experiments till the success of the new substance is assured, and then to go into its manufacture on an immense scale.

"The corn-oil from which the rubber is made comes from the germ of the corn and not from the hull. The starchy and glutinous portions of the kernel are used in making glucose and starch, while the corn-oil, heretofore, according to the refiners, has been practically useless. The five refineries of the trust have used 21,000,000 bushels of corn in the last ten months, of which about 5 per cent. was refuse. Though forty different products are made by the company, still 5 per cent. was practically waste. By utilizing this waste material in making the new product, it is calculated that corn rubber can be sold at 6 cents a pound, 2 cents of which will be clear profit. The corn rubber, it is said, will be adapted to nearly all the uses that ordinary rubber is capable of—from bicycle tires to linole-



FIG. 2.—HIDING PLACE IN THE TEMPLE OF JUPITER AMMON.

View of the walled-up vault in which the statues and inscriptions were found.



FIG. 3.—STATUES DISCOVERED.

To the left, a priestess 3 1/4 feet in height; in the center, Ceres or Demeter, 3 feet in height; to the right, Ceres or queen goddess, of painted white marble, 3 1/4 feet in height.

statement of the discoveries made in the Punic acropolis.

M. Gauckler made his excavations near the cisterns of Bordj-Djedid, in ground on the side of a hill leased to him by the Ben Attar family. This ground extends between the great cutting in which Vernay, in 1885, found the first Carthaginian tombs and the Punic acropolis of Douimes, and which has since been explored with great success by Father Delattre. This region is one of the most important of Carthage. Submerged civilizations have here left traces which appear in the form of superposed strata of sediment from 23 to 25 feet in thickness.

Upon clearing the ground, there are first met with various debris that have been brought to the surface by the plow, such as terra cotta facing tiles, coins, lamps, etc. Beginning at a depth of five feet, Byzantine tombs are found. Beneath this there appear a few structures of this epoch, and, among others, a Roman house apparently dating back to the period of Constantine, although it contains debris of a more remote era. This house is very interesting. In the center of it is remarked a fountain which spurts into a basin. Farther along there are two rooms paved with mosaic. The larger of the mosaics, which is 13 x 19 feet, represents a maritime landscape. In the center there is a turreted pavilion shaded with trees, while all around are numerous individuals fishing or boating. The

painted in bright colors, and of a style thoroughly Pompeian.

One of these fragments represented a maiden (a priestess, no doubt) clothed in white drapery, and her forehead surmounted by a lotus flower. In her left hand she held a large staff terminating in a cross. Alongside there were pagan divinities in marble, exhibiting ancient fractures and marks of deterioration, which demonstrated that they had not been spared by the hammer of the iconoclast. There was found a Venus pudica with the dolphin, a Jupiter seated with the eagle, a Bacchus offering a drink to a panther, a youth seated and wearing the chlamys, a head of Amor, a mask of Silenus, a lion's head forming a waterspout, two terra cotta statues of Mithra (one representing the god treading under foot the head of a bull), some pottery, the lower part of a statuette with the bust of the horse of Carthage, a mask of a diademed goddess, and a portrait of a woman.

This is not all: in a remote corner of the hall there was found fastened against the wall a large slab of white marble bearing a dedication to Jupiter Ammon, identified with the sylvan god whom the barbarians adore: Jovi, Hammoni, Barbaro, Sylvano. Beneath this another hand had more recently added a second dedication. At the foot of this double dedication there was seen in the first place the white marble head of a votive bull carrying between its horns a

erected with an inscription dedicated to Saturn, and then a score of granite beryls and stone balls sometimes traversed by a bronze rod, and some disks or ovoid balls of terra cotta.

This "find" of the balls is not without importance. They had already been met with in large quantities in Carthage, but exactly what they were designed for was not known. They were generally considered as projectiles fired by the Turkish guns of the sixteenth century or by the slugs of the Carthaginian archers.

It seems, however, that these pieces, found in a heap with objects of worship, under a mosaic of the fourth century, are all contemporaneous and of pagan origin. Far from presenting an exclusively military significance, they possess, on the contrary, a votive character.

At the very back of this dark corner of the chamber, in a sort of hiding place, the explorers came face to face with four statues of white marble that were nearly intact. Three of these were a little over three feet in height, while the fourth, a veiled goddess, was smaller and not so carefully executed. The first three formed a triad analogous to that of those colossal statues that the Direction des Antiquités met with in the Sebka of Kheredine now on exhibition in the Museum of Bardo. These latter represent the Carthaginian Isis, who is recognizable by her mantle and diadem ornamented with a crescent, and placed between two priestesses wearing a headdress in the fashion of the fifth century. The first, on the contrary, represent the Greek Demeter (the Roman Ceres Africana, who replaced the Phœnician Tanit), accompanied by the slender Canephora Oncestophora and a young woman entirely draped in perfectly transparent veils. These statues, which are extremely elegant, are chiseled with perfect art from a marble of golden tint and of a very fine grain. A few light touches with the pencil bring out directly the characteristic traits of the sculpture and give the illusion of life. These statues are in a perfect state of preservation. They had been hidden at the very back of the vault, which was afterward carefully filled in and walled up, and then covered with a mosaic that concealed their existence. Why so much precaution to cause the sudden disappearance of all these marvels in this manner? It is very likely that it was desired provisionally to protect these precious idols from the outrages of the Christian conquerors. The last of the faithful of Demeter, the last priests of Jupiter Aimon, Sylvanus and Saturn, at the moment of the defeat of paganism, endeavored to set apart things for the future, still believing in the return of better days. They concealed everything, but their hopes were deceived and things remained as they were. Death surprised them and left their treasures hidden under many feet of detritus and earth.

Beneath the vault, nothing is found except some Punic tombs, and to these we shall return in a subsequent article.—H. Lauriston, in *La Nature*.

A CENTURY OF SPADE WORK.

THE mystic Johan Pico, Erle of Mirandula, was not the first (nor has he proved to be the last) philosopher who has sought to find for the facts of the Book of Genesis a meaning other than the literal significance. Pico, whose name we mention only to contrast the methods of four centuries ago with the methods of to-day, set before himself in his treatise, named "Heptaplus," the congenial but gigantic task of harmonizing the whole body of known philosophy with the teachings and narrations of Moses. Moses was to have in him an intelligent interpreter, who should smooth out the hard sayings of his cosmogony, and place his theology in friendly juxtaposition with the thoughts of such unrelatable people as the Neo-Platonists, the pseudo-Dionysius and the greater thinkers of classic Greece. Under the treatment Moses becomes an allegorist, his facts become the vehicles of theories, his plain statements obscure prophecies, and his first three words a pregnant anagram. We have no fault to find with Pico's heart, he took his Bible seriously, which is more than some moderns can do, and he felt, as good men have felt in all ages, that since what has been written for our learning must have some meaning, if the meaning nearest the surface cannot square with what our small brains hold to be facts, there must either be another kind of fact or another kind of meaning.

Our present century knows other methods. The quattrocentist drove his spade into the dust of living and dead philosophies; no bad digging ground either, for the minds of men are not less real than their bodies, nor are thoughts less actual than tombstones; only the actuality differs in kind. To-day it is different. Our spades, in searching for the roots of the Scriptures, make for the more concrete dust of cities and the ashes of ancient kings, and truly we have dug to such purpose that we may be said from a human and chronological point of view to have outdug the book of Genesis and cut the very sod from Adam's feet. For what have we found? The accepted chronology of the Pentateuch, taken in relation with the book of Kings, has been held to point to 2564 B. C. as the date of the deluge and to 4319 B. C. as that of the creation of man; but the excavations conducted at Nuffar, fifty miles from Babylon, by the representatives of the University of Pennsylvania, revealed six fathoms below the surface a platform of bricks stamped with the names of Sargor and Naram-Sin, who are known to have lived in the thirty-eighth century; below which again, to a further depth of some thirty feet, were found in 1896 the remains of buildings, which, allowing a moderate calculation for the depth of accumulated debris, must certainly be ascribed at latest to the beginning of the sixth millennium! In fact, time is older than we thought, and the men of modern Pennsylvania have found it out.

But this is a discovery of yesterday; we must go back a century. It is exactly one hundred years since a French officer unearthed at the mouth of the Nile a certain black block of basalt which was to unlock the secrets of centuries and to be the basis of an entire department of human knowledge. The attempt to decipher Egyptian inscriptions had occupied men of learning from the sixteenth century onward, but until the Rosetta Stone, with its threefold inscription, offered to the ingenuity of Silvestre de Sacy and Akerblad, the Swede, the opportunity (followed up by Thomas Young in 1818) of interpreting the demotic and hieroglyphic

codes by comparison with the Greek, the conjectures of linguists had been entirely at fault.

The interpretation of the Rosetta Stone was but the opening of a century of similar labors upon all the discoverable monuments of the East; and, indeed, it may naturally be anticipated that the work of the present century is but the prelude to an age of study which need never end till the spade has overturned every acre of the ancient East.

But, though the labors of the recent past may be but the prelude of further discovery, it is proper that the close of a century so remarkable as the present should bring with it some attempt to summarize for ordinary readers the results of the discoveries of the past hundred years. Common man, even if he be intelligent and a reader, does not trouble himself much with accounts of explorations, nor with the transactions of learned societies; and though it may concern and even interest him to know how far his Pentateuch, his new Testament, his Herodotus, and his Homer are supported or discountenanced by the testimony of external witness, he will hardly be at pains to search for these evidences among the scattered reports of archaeological institutes and the isolated writings of individual explorers. Englishmen of thought will therefore (whether they are professed antiquaries or not) receive with welcome the miscellaneous volume* which Mr. Hogarth, the director of the British School at Athens, has recently brought together. Covering as the volume does an immense area of discovery, a great variety of evidence, and the bearing of that evidence on more than one field of literature, sacred and profane, it is impossible in a review to follow the book into the manifold issues with which it deals. We can scarcely do more than indicate that it treats of the relation of archaeological testimony to Old Testament chronology (Mosaic and historic), to the New Testament, especially in connection with the early Christians, on whom there is a scholarly article by the Rev. A. C. Headlam, to the Homeric poems, to Herodotus, and to Roman civilization.

We have mentioned at the head of this article the subject with which, as is natural, the volume opens. It begins at the beginning. "What light," the first writer asks, "can the excavations and interpretations of the century's exploration throw upon the biblical record of the Creation?" The answer, to be brief, is simply this, that the discoveries begun by Mr. George Smith in the Chaldean and Assyrian soil have revealed the existence among the ancient peoples of those lands of a tradition, expressed for the most part in rhythm, which corresponds in very close detail with the sequence of events recorded in the Mosaic accounts of both the Creation and the Deluge.

There is no reason why anybody should on this account shut his Bible with a bang and deny it originality or inspiration. The writer of the article on "Hebrew Authority" is a Canon of Christchurch and a Doctor of Divinity, and yet—perhaps because of this—he does not plead the Bible's cause as strongly as he might. He is content, in fact, to call his witnesses and to leave the case to the jury without a speech for the defense. That speech, if he had made it, would be on these lines: that the Chaldean and Assyrian myths, similar as they are to the Judaic tradition, differ in one important respect—the sequence of events agrees, but the theology differs toto cœlo. The Babylonians have many gods, a divided, inharmonious hierarchy, whose strife reminds us of the conflicts that tear heaven in the Nibelungen Ring, and that stir up the Olympus of Homer and of the Roman poets. In Genesis all is otherwise. Undoubtedly the similar elements of the cosmogony were the common property of the western East. It was the function of the Pentateuch to give to that common knowledge the right, the true theological significance. In other words, the message of Genesis resolves itself into one fact—Monotheism—or perhaps into two, Monotheism and the benignity of God. Perhaps one should say that the view taken of the facts of Creation is the minor premiss of theology, which varies with every generation as varies the knowledge of that particular age. With us it has grown with all that the years and the sages have piled together, but the major premiss may be the same, and our completed syllogism of belief should suffer a change which, under happy conditions, is nothing worse than a growth in the grace of vision. Darwinism, geology, archaeology, transform the minor truth, but do not assail the greater one, which is the gist of the message of Moses. Viewed in this light, neither the agreement of the Mosaic record with the Chaldean legend, nor its disagreement with our newest chronology, are of any but minor importance.

It is natural that those who are interested in the arts should search this publication for some light on the subject which specially concerns them. As it happens, they will search without much direct result. It is true that many of the monuments which convey the evidences under discussion are of themselves works of art not less than objects of archaeology, but they do not in this aspect claim the attention of the writers.

Mr. Ernest Gardner's chapter on Historic Greece is the one which most nearly touches the evidence of exploration on the origins of art. He has something to say in his forty brief pages on sculpture, architecture, and even music, but he necessarily leaves us with the feeling that his topic might easily and rightly have occupied a larger space in the book.

The essays, to be sure, only pretend to be a summary of the results which the century's excavation has attained, but we could well have appreciated something more than the allusive generalization, for instance, in which Mr. Gardner hints at the evidences we now enjoy as to the pre-Periclean Acropolis. "We have," as he says, "a picture of the Acropolis in the period between the Persian wars and the middle of the fifth century," but he makes very slight effort to paint that picture and whets our appetite only to leave us hungering. The excavations at Delphi, Olympia, and Eleusis receive a passing recognition, to be sure, and there is a return to the subject of architecture after an interlude on pottery and sculpture; but again we meet with allusion rather than information, which, after all, is but an evidence that this article is intended rather for

those who know than for those who want to know. The writer pleads that the results of the discoveries subsequent to those of Mr. Penrose are "so intimately bound up with the study of topography that it is impossible to consider them separately. Some excavations have yielded much evidence as to the early development of Greek architectural forms, and this evidence . . . necessitates the re-writing of the history of architecture—a task that still awaits performance." From the rumbling pregnancy of this mountainous sentence there eventuates the "mouse" of information that the Herœum at Olympia shows traces of the growth of stone construction from wooden forms. Dorpfeld's views on the oft-disputed *loyeior* of the Greek theater and four scanty lines of description of a Delian house complete the summary of these epoch-making discoveries. We could hardly complain of this scanty measure of facts were it not that in the other articles, such as those dealing with the chronology of the Books of Kings and with the constitutional economy of Rome, there is dealt out to the reader not merely reminiscences of what he is supposed to already know, but food for fresh knowledge. To do Mr. Gardner justice, we must admit that he draws attention in one section of his essay to an important change which has come over our knowledge of one branch of Greek art—the painting of vases. The very name Etruscan, which used to be loosely but persistently applied to almost every example of this art, is now abandoned except "in conversation." We are now aware, through the Athenian excavations, of the Attic origin of this art. We are able to distinguish the Greek work from its Italian imitations, and even to give a date to the various phases of the work. Nay, more; we now know that good and bad are not respectively synonymous with early and late, but that in Athens, as in Piccadilly, the same year could produce art both excellent and worthless.

We must not conclude this notice without mention of the picturesque description given by the editor of the work of the romantic Schliemann. Vixere fortes ante Agamemnona a saying whose proof, as Mr. Hogarth points out at the head of his article, has been abundantly supplied by the sanguine toil of this illustrious German. "Henry Schliemann, in 1868, brought his hard-won wealth and childlike belief in the accuracy of the Homeric epics to the area of Homer's world. Money, an intimate and uncritical knowledge of the epic text, boundless enthusiasm and equal persistence, a simple faith impervious to ridicule, and a humility always ready to be taught and to share credit with others—these were his stock-in-trade." He felt that he had only to dig and he should find the Palace of Ulysses, the bones of Agamemnon, and the citadels of Troy. His first essay in Ithaca met with disappointment, apparent success came on the supposed site of Troy, where, in 1873, he found a burned city and a kingly treasure which roused the heart of Homeric England and her Homer-reading Gladstone. Driven by the hostile Turk from the Troad, Schliemann next turned his thoughts to where Pausanias pointed at the tomb of Atreus, and again in 1876 his spade struck treasure. "Gold appeared in abundance never before seen in Greek tombs; . . . ivory, silver, bronze, alabaster were there as well, and in profusion, the whole treasure in mere money value being worth thousands sterling." Bodies were there, too, and among them one with "half-shut eye," who figured in the hopes of Gladstone and in the inferences of the discoverer as the hero of Tragedy, to whom Clytemnestra had denied the rights of burial. Such sanguine conclusions were naturally followed by the disproof of many of the assumptions, and finally by ridicule, which submerged alike the value as well as the trivialities of the discovery. To-day, after twenty years, opinion, as Mr. Hogarth points out, has very nearly come round to Schliemann. Whether he found the real Agamemnon or not, he almost certainly unearthed what Pausanias and his contemporaries regarded as the sepulcher of the kings of Mycenæ. In any case, "the gain accruing to science from the Mycenæ hoard" lies apart from these questions of identity. The discoveries proved, and this fact alone is of incalculable value, the existence in Greece of a cultivated prehistoric and pre-Hellenic civilization. What Schliemann found were the evidences of a comparatively late stage of what is now, for want of a more ethnological term, called "Ægean" civilization, a civilization whose reality cannot be questioned, and which supplants alike the "Phœnician" theory that still accounts, in some minds, for the early culture of Mediterranean lands, and those comprehensive "Pelagii" who twenty years ago covered in the Greek history of our schools and universities the realm of the unintelligible and the unknown.—The Builder.

OUR TRADE WITH GERMANY.

TRADE relations between the United States and Germany, which are just now the subject of considerable discussion, do not appear to have been seriously affected up to the present time, if judged by the latest figures of the Treasury Bureau of Statistics. These show that in both imports and exports the commerce between the United States and Germany in the fiscal year 1899 was greater than in 1898, and that the grand total of the commerce between the two countries in 1899 was larger than in any preceding year. The total commerce between the United States and Germany in 1899 was \$240,015,074, against \$224,737,351 in 1898, and \$236,456,632 in 1897, and prior to which time the total commerce between the two countries never reached as much as \$200,000,000, the 1896 total being \$192,138,090; that for 1895, \$173,067,818, and \$189,429,118 in the phenomenal year of 1892. The exports from the United States to Germany in 1899 were the largest in the history of the trade between the two countries, being \$155,772,279, against \$155,039,973 in the fiscal year 1898, and \$125,246,088 in 1897, prior to which year it never reached the one hundred million dollar line, except in the great export year 1892, when it was \$105,521,558.

The importations from Germany in the fiscal year 1899 were \$14,545,367 greater than in the preceding year, being \$84,242,745, against \$69,697,378 in 1898 and \$111,210,614 in 1897, the only year in which the importations from Germany crossed the one hundred million dollar line.

The balance of trade in favor of the United States in the fiscal year 1899 was \$71,529,476, against \$85,342,-

* "Authority and Archaeology. Sacred and Profane: Essays on the Relation of Monuments to Biblical and Classical Literature." By S. R. Driver, D.D., Ernest A. Gardner, M.A., F.R.S., Griffith, M.A., F. Haverfield, M.A., A. C. Headlam, B.D., D. G. Hogarth, M.A. Edited by David G. Hogarth, Director of the British School at Athens. London: John Murray, 1899.

594 in 1898, \$14,035,474 in 1897, and \$3,656,364 in 1896. During the decade 1890-1899 there have been seven occasions in which the balance of trade was favorable to the United States and three in which the balance was against it. The total imports into the United States from Germany in the decade of 1890-1899 were \$85,063,402, and the total exports from the United States to Germany \$1,085,826,756, the balance of trade in favor of the United States in the full decade being \$200,761,354.

TRADE WITH THE BRITISH WEST INDIA ISLANDS.

THE details of the commerce of those portions of the British West Indies with which reciprocity treaties are under consideration are discussed somewhat in detail by the Monthly Summary of Commerce and Finance, just issued by the Treasury Bureau of Statistics. The imports of Jamaica and Barbadoes, with which reciprocity discussions have reached such an advanced stage as to render this subject a matter of special interest, amount to nearly \$15,000,000 annually. Discussing the details of the commerce of these two islands, the Summary says:

Jamaica, the largest of the British West India islands, lies 90 miles south of Cuba and 100 miles west of Hayti; has an area of 4,300 square miles and a population of 640,000. The total number of acres under cultivation and care in 1897 was 663,560, of which 498,916 was under pasture, 28,764 acres was devoted to sugar cane, 22,387 to coffee, 19,760 to bananas, 10,799 to coconuts, 1,611 to cacao, 962 to pimento, 245 to corn, and 80,656 to ground provisions. The tillable soil of Jamaica has, since the abolition of slavery, passed to a great extent from the hands of large holders to those of small owners, and the productions have at the same time been greatly diversified, coffee, bananas, coconuts, and cacao having, in many cases, occupied the area formerly devoted to sugar cane. Business facilities include a colonial bank with a circulation of \$1,985,097 and assets of \$17,993,644. The government savings bank has 30,660 depositors with deposits amounting to 468,199 pounds sterling. The local currency is that of Great Britain, but various American coins are also current. The registered shipping of Jamaica consists of 124 sailing vessels of 6,694 tons, and one steamer of 450 tons. There are in operation 185 miles of railway and 937 miles of telegraph.

The products of Jamaica are, besides tropical fruits already mentioned, dyewoods, cabinet woods, spices, and other valuable tropical products. The coffee raised in certain districts of the Blue Mountains brings, it is said, the highest price paid for coffee in the London market. The exports from Jamaica in the year 1897-98 included 85,410 cwt. of coffee, 445,866 pounds sterling of bananas, 11,533,726 coconuts, 88,013,091 oranges, 1,408,166 pounds of ginger, 1,379,278 gallons of rum, 284,375 cwt. of raw sugar, 42,600 tons of logwood, and 38,828 cwt. of pimento. The total value of the exports of 1897-98 was 1,448,443 pounds sterling, and of the imports 1,660,667 pounds sterling. The imports included 32,657 cwt. of bread and biscuit, 7,898 cwt. of butter and compounds, 56,628 tons of coal and coke, 300,401 bushels of corn, 37,063 barrels of meal, 208,317 pounds sterling of cotton manufactures, 118,612 cwt. of dried or salted fish, 147,616 barrels of flour, 28,424 pounds sterling of hardware and cutlery, 35,775 pounds sterling of linen manufactures, millinery, and haberdashery, 9,500,000 feet of lumber, 8,500,000 pounds of rice, and 2,403,120 pounds of soap. Of the 1,666,667 pounds sterling value of importations in 1898, 776,889 pounds in value was from the United Kingdom, 719,768 from the United States, 118,898 from British North America; while of the 1,448,443 pounds sterling value of exports in 1898, 313,853 pounds went to the United Kingdom and 602,932 to the United States.

Jamaica was discovered by Columbus May 3, 1494, taken possession of by the Spaniards in 1509, but taken, in 1655, by a British expedition sent out by Cromwell, which, after an unsuccessful attempt to capture the island of San Domingo, seized Jamaica, which has since been held by the British government, having been ceded to England in 1670.

The island of Barbadoes, with whose government a reciprocity treaty has already been signed, lies on the east of a chain of islands which stretches southwardly from Porto Rico to the coast of South America, and which geographers divide into "Windward" and "Leeward" groups. Its population is, according to the Statesmen's Year Book of 1899, about 190,000; its area about 166 square miles, and the area under cultivation about 106,470 acres. The staple product of the island is sugar, about 30,000 acres being annually planted with sugar cane, which yielded, in 1897, 58,600 hogsheads of sugar, as against 36,451 in 1895, and 49,399 in 1896. There are 441 sugar works and 9 rum distilleries. Sugar is the chief export, though 1,880 tons of "manjak" or "glance pitch"—a bituminous petroleum for fuel—was exported in 1897. In the exports of that year were 56,397 hogsheads of raw sugar, valued at \$2,058,417; 2,203 hogsheads of other sugar, valued at \$120,426; 37,493 puncheons of molasses, valued at \$418,978; 45,449 quintals of dried fish, valued at \$222,502, and considerable quantities of coal, corn, flour, and manufactured articles, much of which was apparently imported into Barbadoes, and distributed thence to others of the West India group. The imports included 3,947,761 pounds of bread and biscuit, 770,280 pounds of butter and compounds, 19,749 tons of coal and coke, 304,973 bushels of corn and other grain, 46,688 barrels of Indian corn meal, 55,089 barrels of flour, 83,453 quintals of dried fish, \$231,620 value of hardware and metals, \$657,522 of linen and cotton goods, 9,516,281 feet of lumber, 2,891,430 pounds of salted or pickled meat, 4,581,858 pounds of oil meal and oil cake, 9,211,785 pounds of rice, 1,649,968 staves and shooks, the total value of the year's importations being \$4,908,833, of which \$2,309,577 came from the United Kingdom, \$529,645 from North America, \$1,566,564 from the United States, and the remainder from British India, British West Indies, British and Dutch Guiana, and Peru. Of the year's exports, which amounted to \$3,582,537 in value, \$2,080,535 came from the United States.

Facilities for satisfactory transaction of business include a colonial bank, with a paid-up capital of 600,000 pounds sterling, having a circulation of \$1,985,097. The chief city, Bridgetown, has a population of 21,000,

with three daily, two weekly, two bi-weekly, and two monthly newspapers. The registered shipping of 1897 consisted of forty-eight sailing vessels and two steamers; total tonnage, 7,105 tons net. There are upon the island 24 miles of railroad, 470 miles of wagon road, 24 miles of telegraph line, 35 miles of police telephone line, and 600 miles of private telephone line, which supplies 406 services. Barbadoes is a station of the West Indian and Panama Telegraph Company. Its distance from New York is 1,820 miles; from Porto Rico, 449; and from Liverpool, 3,705 miles.

TRANSPORTATION ROUTES OF THE WESTERN HEMISPHERE.

A MAP of America showing the transportation routes of North, Central, and South America, just issued by the Treasury Bureau of Statistics, gives some interesting data on the relative distance between the commercial centers of the United States and those of other parts of the world via the various existing and proposed water routes. It shows especially the routes followed by steamships in the commerce between the eastern and southern ports of the United States and of Central and South America and the western coast of the United States. The contrast between the distances now traversed in commerce of eastern United States with western coasts of America and those which would be made practicable by an isthmian canal is interesting. The fact that the Isthmus of Panama lies almost directly south of the Atlantic coast ports and that all commerce for the western coasts of South America must now travel eastwardly a distance of over 2,500 miles and again back to the west a like distance before reaching the western coast of South America indicates in some degree the loss of distance and steam power which must be utilized in reaching the western coast of South America, contrasted with that which will be practicable should a water route be opened across the isthmus. From New York to Valparaiso, on the western coast of South America via the Straits of Magellan, is shown to be 8,460 miles, while via Colon and Panama it is but 4,572 miles; while from New York to San Francisco via the Straits of Magellan is 13,000 miles, while via Nicaragua it is 4,867. The commerce of the west coast of South America, as shown by the publication of the Bureau of Statistics which this map accompanies, now amounts to over \$100,000,000 annually, and of this sum but \$15,000,000 is with the United States. The imports of Chile, Peru, Ecuador, and Bolivia amounted, in 1897, to over \$50,000,000, and of this amount less than \$5,000,000 was from the United States. Thus, in that part of the commerce in which the United States producers and manufacturers are most interested—the export trade—the United States now obtains less than ten per cent. of the trade of the Pacific coast of South America.

Regarding the details of the trade of the western coast of South America, the special publication of the Bureau of Statistics relative to the commerce of Central and South America has the following: "Chile, which occupies the southern half of the western coast of South America, about equals in size the States of California, Oregon, and Washington, the area being 290,829 square miles and the population 3,049,352, or about two-thirds that of New England. Lying largely within the temperate zone, it has developed a greater variety of industries and with greater success than its neighbors lying nearer to the equator. About one-half of its population is engaged in agriculture, the wheat product alone being about 28,000,000 bushels, other cereals amounting to about 8,500,000 bushels, besides fruits and vegetables. Sheep and cattle are largely grown, and wool, hides, and leather form the important features of her exports. The most important of the exports, however, is nitrate, the exportation of which is rapidly increasing. The imports in 1897 are given at \$23,908,524, of which \$10,614,775 was taken from the United Kingdom, \$6,013,230 from Germany, \$1,624,485 from the United States, \$184,428 from Spain, and \$4,474,606 from other countries, thus indicating that the United States has less than seven per cent. of the imports of Chile. The Statesman's Year Book gives the value of the imports into Chile in 1896 at 30,249,003 pesos from Great Britain, 20,080,943 from Germany, 6,807,165 from United States (value of peso, 36½ cents). The imports of 1897 included sugar, valued at 5,983,659 pesos; coal, 4,132,918; illuminating oil, 1,458,090; cashmeres, 1,221,918; tea, 1,046,256; and galvanized iron, 1,292,176 pesos. Chile was the first state of South America in the construction of railways. In 1897 the total length of her lines open for traffic was 2,661 miles, of which 1,233 belong to the state. The trans-Andine line, which is expected to connect the Pacific with the Atlantic from Valparaiso, Chile, to Buenos Ayres, Argentina, lacks but 40 miles of completion. Recent appropriations for completing the tunnels required for this purpose encourage the belief that it will soon be completed and through land transportation thus given between the Pacific and Atlantic at this point.

Peru, which stretches northwardly from Chile, has also an area equivalent to that of California, Oregon, and Washington combined, being 463,747 square miles, and a population slightly greater than that of Texas, being 2,621,000. The imports of Peru in 1897 are given at \$8,065,792, of which amount \$737,858, or 9.15 per cent., was from the United States, while \$3,060,736 was from the United Kingdom, \$1,370,880 from Germany, and \$585,536 from France. The chief productions are cotton, coffee, and sugar. Cinchona, India rubber, dyes, and medicinal plants are also features of the products. The foreign commerce, which is chiefly with Great Britain and Germany, is carried on from several ports, of which the principal are Callao and Mollendo. The 1897 imports are given at 18,004,048 sols (value of sol, 43.4 cents); the chief exports are sugar, silver ore, copper ore, coffee, wool, rubber, cocaine, and coca-leaves. Over one-third of the imports into Peru is from Great Britain, one-sixth from Germany, and one-ninth from France. The chief exports from Great Britain to Peru in 1897 were woollens, cottons, iron, wrought and unwrought, and machinery.

Ecuador, which lies directly north of Peru, has an area of 120,000 square miles, about equal to that of Ohio, Indiana, and Illinois combined, and a population of 1,272,000. Although lying directly under the equator,

the great elevation of its table-lands gives very considerable variety to its products. Coffee, cacao, rice, sugar, rubber, cabinet woods, chemicals and minerals, are its chief products and exports. Its chief imports are cottons and other tissues, provisions, manufactures of iron and steel, clothing, and mineral oil. Fronting as it does only on the Pacific, its distance by water from the eastern part of the United States is very great, and as a consequence its purchases are largely from European countries. The exports from the United States to Ecuador have never reached \$1,000,000 annually, the nearest approach being in 1891, when the total was \$903,159, though that of 1898 was \$855,193. According to the message of the President of Ecuador delivered in 1898, the imports of 1897 amounted to 18,004,048 sucres (value of sucre in 1897, 47.4 cents; present value, 43.4 cents). British exports to Ecuador in 1897 amounted to \$2,000,000, the chief articles being cotton goods, \$1,350,000; woollens, \$200,000; and iron, wrought and unwrought, \$130,000.

Bolivia being entirely an interior country and having no seaport, the official statistics are fragmentary and largely estimates. Imports and exports pass chiefly through Antofagasta, Arica, and Mollendo on the Pacific coast, and in smaller quantities through the eastern river ports, Porto Suraz and Villa Bella. The total imports in 1897 are estimated at 24,467,100 bolivianos (value of boliviano, 43.4 cents). The chief imports are provisions, hardware, spirits, cottons, woollens, silks and clothing, and the chief exports silver, tin, copper, coffee, and rubber. Bolivia has an area of 567,380 square miles, or considerably greater than that of the entire group of Southern States east of the Mississippi River, with a population of 2,019,549, or considerably less than that of North and South Carolina combined.

THE CHEMISTRY OF COLD STORAGE.

By General S. H. HURST.

TRUE it may be that the world is old, and that in the long ages of human history men would have supposedly sought out, and found out, nearly all the ways that lead to human comfort and luxury and wealth. And yet discovery follows discovery, and invention crowds upon invention, until it would seem that we are living in the early morning of the world.

But a few years ago the discovery was made by thoughtful or accidental experiment that ripe fruits and many choice vegetables could be preserved for use during all the year, retaining their natural and delightful flavors, and thus lengthening and multiplying many times over the season of their enjoyment by all mankind. The great secret of "hermetic sealing" had lain like an undiscovered nugget through all the ages just beneath the crust of everyday human thought, until someone broke that crust, and the nugget shone out with a light so full and so useful as to enrich the lives of untold millions of people. And the art of "canning," more than anyone can dream (much less compute), has become a great and lasting blessing to the whole civilized world. And then, just a little later, in this same field followed the scientific discoveries and practical triumphs of refrigeration, which widened the field of human industry, and added more to the comfort and luxury of human life than any other discovery of the nineteenth century. The fact that in most climates vegetable and animal products, when robbed of the principle of life, decay rapidly in warm temperatures, and resist decay in cold atmospheres, had of course been known through all history. But the value of the practical application of that great truth of nature in the affairs of everyday life had not been understood or determined until the present generation. But now it has been demonstrated that great storehouses, holding thousands or tens of thousands of bushels of selected fruits, can be filled with cold air, and so steadily and evenly held at a low temperature and at a given degree of humidity that the fruit in its natural state, charming and beautiful and luscious as it came from the tree or vine, can be kept in almost perfect condition, substantially all the year round. And that ear loads and ship loads of beef and pork and other meats, fresh from the abattoirs of our western cities, can be safely carried, and are being carried, to all the great markets of the world.

It is certainly worth our while to look into this simple, but newly discovered and applied, law of nature, upon which all the claims and triumphs of refrigeration are based, and to have an intelligent understanding, not simply of the facts, but also of the philosophy of this wonderful law. We are, however, accustomed to use that word "philosophy" as applying to the law or spirit of harmony, by which the separate and specific laws of nature blend into and supplement each other, making a great system of natural principles of law divinely harmonious and beautiful. And so we think it more fitting to speak of the workings of that underlying and newly applied law which makes refrigeration such a blessing to mankind as the "chemistry of cold storage."

Long ago scientific men determined that the first stage of decay in animal and vegetable matter was a simple form of fermentation. Further along, scientists became convinced that fermentation was a condition of matter produced by the existence and limitless multiplication of infinitesimal bacterial life. At first these bacteria were supposed to be microscopic germs of vegetable life. But in later years they have been regarded as animalcules, and the truth became more and more conclusive that these animalcules, by their presence and work, promoted fermentation and decay in all vegetable and animal matter. To defeat the work of these agents of fermentation and decay then became the object of scientists. And it was first discovered that these animalcules could be destroyed by heat, as in the process of canning fruit at boiling heat, and then hermetically sealing it, so as to shut out all living germs, and defeat entirely the march of fermentation. In canning corn and vegetables it was discovered, however, that a greater degree of heat than 212° F. was demanded. And a brine of calcium chloride has been used, in which the filled and closed cans were heated to 230° and 250° F., and it was thus proved that the infinitesimal agents and chemical processes of fermentation and decay could be absolutely defeated by the agency of heat. And then followed, like a revelation, the truth that the same end could be accomplished by intense cold, the truth being already demonstrated by

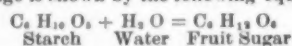
experiment that at or near the freezing point all bacterial life was either paralyzed or destroyed; and with other favoring conditions all possibility of fermentation and decay was as certainly defeated. And when these truths were established by practical experiment, then at once was widened to an almost limitless degree the possibility of the preservation of food products through all seasons, and in all climates.

Experience has shown that three conditions are necessary to the best results in cold storage of fruits: (1) a low temperature; (2) an even temperature; and (3) a certain degree of humidity that will prevent the wilting of the fruit, keeping it plump and crisp, and yet not producing fungus or mould.

The chemical changes that occur during the maturing or ripening of fruits, whether on the tree or while in the barrel or bin, are alike simple and beautiful.

If you take a perfect green apple—green simply in the quality of being unripe—and place it under cover in a medium temperature, it will not rot while it remains green. But if you take a ripe apple of the same variety and place it in the same temperature, it will begin to decay at once. And the reason of this difference is quite plain. The green apple is full of starch, and starch does not ferment, but the ripe apple is full of sugar, which does ferment. So that whenever an apple is fully ripe, in ordinary temperatures its sugar begins to ferment, and the fruit gets over-ripe or decaying. The truth is, however, that starch and sugar are composed of exactly the same chemical elements, but in different proportions, and that the ripening of the apple is but a chemical process, by which the starch of the green apple is changed or transformed into the sugar of the ripe apple by the simple addition of water.

This change is shown by the following equation:



And it is clear that until the transformation of the starch into sugar is completed by the vital chemical processes of ripening, fermentation or decay will not begin.

And now comes the application of that universal law that heat up to a very high temperature promotes fermentation and decay, while cold retards and ultimately defeats them both. Even apples in which the ripening process is substantially completed, when placed in a temperature at or near the freezing point, stand for weeks or months without deterioration. On these great truths rests the marvelous value of cold storage, about which the world is just beginning to learn. It may be that there are other forms of ferment besides bacterial fermentation, and it may be that there are other forms of decay besides that of fermentation. But it is none the less true in either case that the preserving power of cold storage can keep the products of our orchards, gardens, and fields in perfection through all the seasons, and enable us to send them in almost limitless quantities to the markets of every zone.—Ice and Refrigeration.

ACTION OF LIGHT ON BIRDS' FEATHERS.

Does light have an influence in changing the color of those parts of animals that are exposed to it generation after generation? Evidence showing that it does has been adduced in a recent study of East Indian birds. The question is wide reaching, because, if it is to be answered in the affirmative, acquired qualities must be inheritable, and the great point about which biologists have wrangled for years is settled. The observations just alluded to are described as follows in the *Revue Scientifique*: "The action of light on colors in general is well known. It is observed in many cases with birds; at least, so Messrs. Meyer and Wigglesworth concluded from their study of the birds of Celebes. They have observed several facts that support their conclusion. For instance, in the case where the wing rests on the body, there is a change of color, with almost all birds, on the interior face of the wing feathers where these come in contact with the body when the wing is folded; and between the color of this face and that of the outside of the same feathers there is a difference that is often very marked. The part not subject to the constant action of the light is white in some birds, while exposed parts are black. With one species of parakeet, the wing-feathers are blue-green on the side that touches the body, and black on the other side; and it is the same with others. The *zecephus* has wings that are rusty below and blackish above. Another class of instances is observed when the tail feathers are partly covered by the feathers that protect them; the former are paler at their bases, and tend toward white. This is seen very clearly with several birds that have the exposed part black. The base of all feathers, where they are protected, is paler and less brilliant in tint. Light has an evident influence on the pigmentation of the plumage. The first birds mentioned are quite black when seen from above; while from below they appear white. Wherever their feathers are exposed to the sun, they are black; where protected, they are white. With cage-birds the opposite is often seen; the plumage becomes dark when they are kept in the shade, and is more brightly colored when they are exposed to light."

A SOURCE OF INTENSE MONOCHROMATIC LIGHT.

An article by Ch. Fabry and A. Perot in *Comptes Rendus* on the above subject is abstracted as follows in *The Journal of the Chemical Society*: To get this monochromatic light an electric arc is employed passing between mercury poles in a vacuum. The apparatus consists of a cylindrical glass bulb filled to one-third its height with mercury, which is divided into two masses insulated from one another by means of a glass tube concentric with the walls of the bulb and opening nearly on a level with the mercury. Each mass of mercury is connected with a pole of a source of a continuous current by means of platinum wires fused through the glass. The bulb is made as completely vacuum as possible, and in order to strike the arc the apparatus is slightly shaken, which brings the two masses of mercury momentarily in contact. The difference of potential between the poles does not exceed 15 volts, but in order to secure a steady arc, 30 volts should be available. A current of two to three

amperes is sufficient, but stronger currents may be used, and the intensity of the light may reach one candle (approximately 7.4 candles). The spectrum of the light is identical with that of the light from Michelson's mercury vapor tubes, and consists of a violet ray 4358.0, a green ray 5460.7424, and two yellow rays, 5769.5984 and 5790.6593; the separate rays can be isolated by means of a prism or by the use of suitable absorbents, such as yellow glass or potassium dichromate for the violet ray, a saturated solution of didymium chloride for the two yellow rays, and a solution of eosin for the violet and green rays. For photographic purposes, the ultra-violet rays should be cut off by an acid solution of quinine sulphate.

THE MANUFACTURE OF CARBONS.

CARBON, in some form, is usually a prominent factor or element in every machine or appliance employed for the production or use of electric energy. The human eye seems to be so designed that it is co-related to the light rays given off in the burning of carbon, so that this substance, in some form, has been employed by men for light in all the ages, from the pine knot and animal fat in primitive times to the latest developments of modern lamps, whether oil, gas, or electric light. To tell how it is refined and fitted especially for electric service is the mission of this article. The facts which form the basis of the story were ascertained on a trip to Cleveland, where a visit was paid to the works of the National Carbon Company, which are located near the western limits of the city.

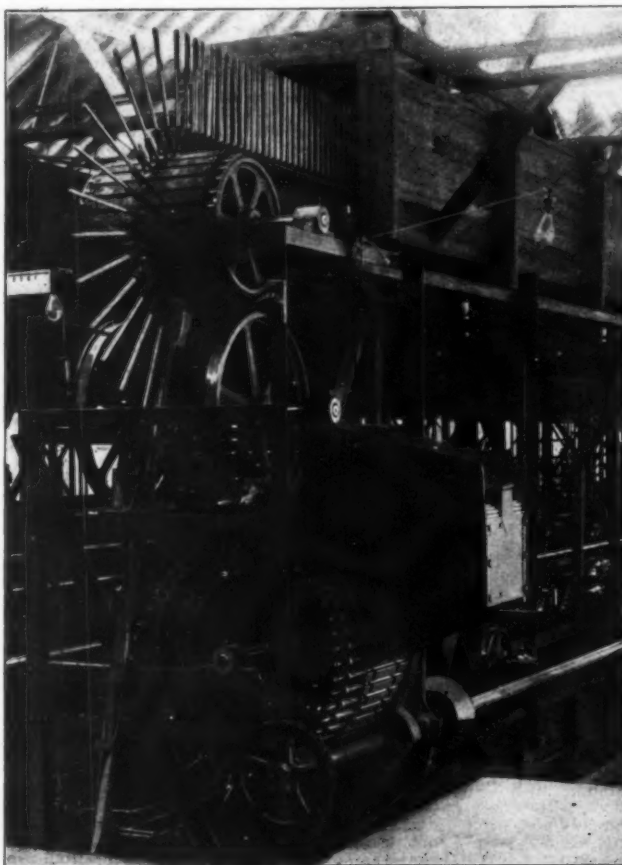
These works are of special interest, being, it is claimed, the best equipped and most extensive works devoted to this industry in existence. The buildings are of brick, seventeen in number, arranged in parallel lines, and cover twenty-three acres, in which about

and other impurities are consumed, leaving the charge virtually as pure carbon. In the process of calcining, the gas is turned on or off by degrees, and, after cooling to a certain degree, the material is hauled out through doors in front and falls into a metal trough running along in front of the retort, in which is a link belt conveyor, by means of which it is delivered to a point near the middle of the building, where it is again elevated, and by means of a conveyor directed along above a long iron floor, to which it falls through flexible chutes, which, by being properly manipulated, deliver it in an even layer over the floor, where it is left to cool.

From this floor it drops to a conveyor, which delivers it to an adjoining building, where it is again elevated and delivered to the grinding mills, of which there are a number, both vertical and horizontal, the latter of which are similar to the burr-stone mills employed in grinding grain. From these, by suitable conveyers, the powdered material is delivered to a set of bolting machines by which it is separated into different grades, the coarser grades being returned and re-ground, as is also all scrap from imperfect carbons. Following the bolting process, the material is delivered to the mixing room, where are a number of iron barrels or boxes, which revolve like the rattlers used in foundries. These are heated by steam and in this process the binding material is incorporated with the carbon powder.

The binding material is a product which has also been prepared by a special process, and which has been ground and bolted in about the same manner as is the carbon. Being suitably mixed, the material is conveyed to a cooling department, where it is made ready for the molding or forcing process.

In the making of the lighting pencils two processes are followed; one is known as the molding process and the other the forcing. In the former the material is



THE AUTOMATIC PLATING MACHINES.

eight hundred men are employed. The products are not by any means confined to lighting carbons, but embrace a great variety of chemical battery elements, as well as complete primary batteries for all purposes; also telephone transmitter parts, including back plates, diaphragms and their companion granules or carbon shot; also carbon motor and generator brushes, lighting arresters, rods, and strips of various sections, including those of large diameter employed as smelting electrodes and for electrolytic purposes.

To write the full history of the material from which the ordinary lighting and battery carbons are produced, it would be necessary to visit the Pennsylvania petroleum wells, and ask of Nature the secret of its production, and then follow it to the tide-water refineries, for the material is known as coke, and is a by-product of the process of oil refining, being the solid product or residuum that remains in the stills of the refineries after the oils have been evaporated. This is delivered to the carbon works by the car-load and comes in irregular chunks or bodies of black porous material, somewhat lighter than coal-coke. This material is stored in great quantities in a long pile thirty feet high in the receiving department, which occupies one end of a long building, the other end being occupied by the calcining retorts and cooling floors.

It is first ground in a vertical bark mill to what is known as pea-size, and from this, by means of belt elevators, it is stored in large iron tanks above the retorts. From these it is drawn into small iron cars which run along on top of the retorts, and discharge their contents directly into the calcining ovens, where it is subjected to a high temperature by the burning of gas, which is manufactured from coal on the premises. The ovens are kept closed so that the material burns in its own gas, by which process all the volatile matter

carefully weighed, and then placed in the molds, which consist of grooved plates of steel containing from twelve to eighteen forms, depending upon the diameter of the pencils to be molded. An attendant carefully packs and adjusts the material, then smooths it off with a straight-edge, but there is no excess of material, so accurate is the weighing process. The molds being in two parts, the second or upper part is now placed upon the powder and pressed down with the hand, when it is ready for the press. The molders occupy little booths with tables on each side of a pair of endless chain conveyers which run in opposite directions, and upon these the molders place the filled molds, which are then conveyed in the direction of the hydraulic presses. Before reaching the latter they are led over a slow-running conveyor which passes through a furnace heated by gas, and when they emerge they are placed by an attendant upon the head of the vertical plungers of the presses, of which there are two, one on each side of the line of conveyers. A second attendant manipulates the valves, when the two parts of the mold are pressed together with great force and then released, when the attendant removes the mold and its contents from the press and places it upon the return conveyor, by which it is taken back and removed by each molder as his mold comes in position.

The molds are returned still hot, and each molder, after removing the formed pencils, which are held together by a thin web of material, places them upon a corrugated pan, on which they are held straight until cool, and by which they are removed and conveyed to the stripping room. To refill the molds the attendant first gives them a coating of oil and then weighs out the material as before described. There are a number of molders employed to each pair of the chain conveyers, and there are several pairs of conveyers. In

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the stripping room the pencils are broken apart by hand and deftly fed one at a time into the strippers, which automatically draw them through very rapidly and shave off the portions of the web that may adhere to the sides of the pencils. At this work some of the hands become very expert, being able to break apart and feed into the machine more than a hundred pencils a minute. From this department the pencils go to the baking furnaces.

We will now follow the material as it is formed by the forcing process; and, in this department, we find a number of presses which are large horizontal machines called Jumbo presses, having cylinders of large dia-

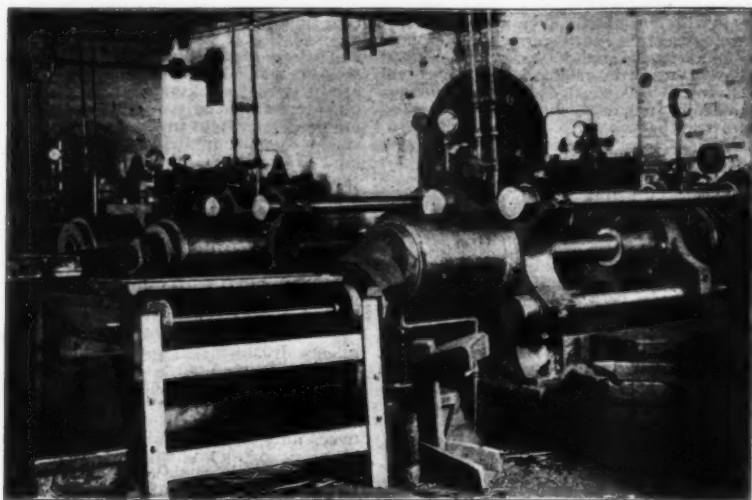
of baking and covers the bed with a scale, so that the gas which is employed as fuel does not come in contact with the carbon. The process of baking requires eight to ten days, and the fuel gas is manufactured on the premises. After being allowed to cool, the top of the oven is removed, when the pencils are lifted out by means of forks, not unlike hay-forks.

Being placed on suitable racks, the carbons are next delivered to the inspecting and sorting rooms, where they are carefully sorted and tested for straightness. For this purpose they are allowed to roll down the inclined surface of a steel plate in such a position that the attendant is able to detect any crookedness in the

ing is done in the ordinary manner by suspending the blocks in the electrolytic solution, where they remain until thoroughly plated. Formerly the lighting pencils were plated in the same manner, but more recently new machines, entirely automatic, have been installed. From this process the carbons are delivered to a traveling conveyer which connects with the packing room.

The testing department, which is one of the most important in the production of perfect carbon, occupies a large room on the second floor of one of the principal buildings, and here are provided a number of arc lamps of different types, in which samples of pencils from each furnace are tested for life and efficiency, there being suitable ray testing lenses for determining the light-giving rays.

In order to complete the story of the manufacture of the battery and telephone elements, it will be necessary to return to the molding department, and here we find a large number of hydraulic presses of curious design and various shaped molds in which the great variety of designs are formed, the materials in all cases being carefully weighed and packed in the molds, when either a screw or hydraulic pressure is applied. In such batteries as have the cover and cup of carbon, the threads by which the two parts are screwed together are formed in the process of molding. Telephone diaphragms are molded in very thin sheets and cut out in round forms in the process. These various forms, including the battery and telephone parts, are then baked or fired in about the same manner as described for the pencils.—American Electrician.

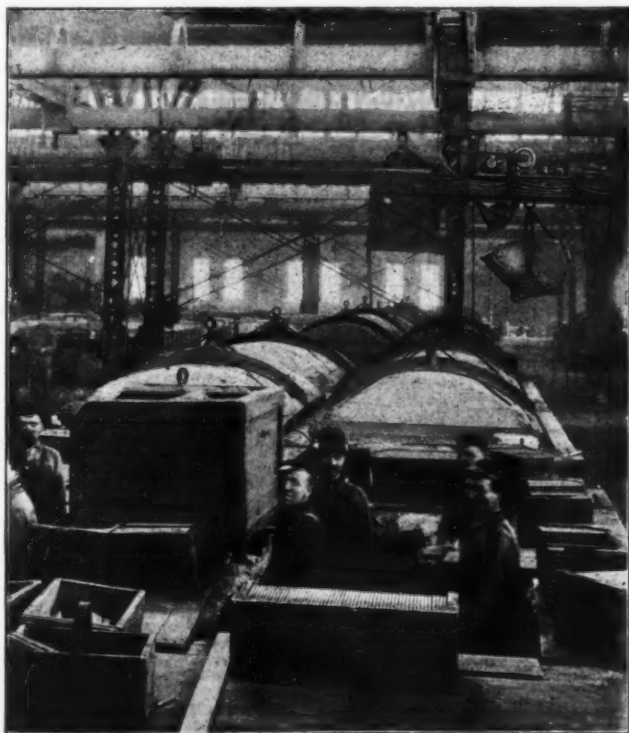


THE JUMBO FORCING PRESSES.

meter, in which plungers are fitted and by which the material is forced through dies in the outer end of the cylinder. Before it is placed in the presses, the material is formed into compact cylinders by hydraulic pressure; then these billets are fed one after the other into the cylinders of the press. The size of the rod or form depends upon the die; and, for making the lighting pencils, the material is forced out into grooved trays and broken off in lengths of about four feet, in which they are left for a time to cool, after which they are cut up into various lengths by being placed in a frame with suitable adjusting and cutting appliances. The same process is followed in forming the large rods employed for electrolytic purposes. Some of these are three inches or more in diameter.

The baking process follows, and all types of carbons are subject to about the same degree of heat. The baking furnaces occupy one of the largest buildings, covering perhaps six acres, which is provided with three large brick smoke-stacks that provide a draught

pencil by means of the light rays that can be seen between the plate and the pencil. From thirty to forty hands are employed in this work. They are usually sorted into three grades, known as No. 1, No. 2 and culls; only the No. 1's, however, are employed for long pencils, the others being cut up into short lengths designed for use as the lower carbon of a lamp, being usually about seven inches in length, while the ordinary length of the long pencil is twelve inches, and in some cases fourteen. The culls and seconds usually provide enough of the shorter lengths, so that only the long pencils are molded or forced. Such pencils as have been formed by the forcing process have now to be pointed, and this is done by machines especially constructed and said to be recent inventions, for which patents have been applied for. In the same department are machines for accurately planing motor and generator brushes, in which a number of brushes are clamped in position and are moved along against the face of an emery wheel. In the same department are



THE BAKING FURNACES, WITH CRANE FOR SHIFTING FURNACE LIDS.

for the entire lot of furnaces. These furnaces are constructed of fire-brick and are provided with a removable arched roof; the roof being composed of fire-brick, but held in shape by means of bars of channel iron, and so designed that they can be removed and shifted about from one furnace to another by means of overhead traveling electric cranes. The furnaces are filled with the pencils, which are carefully piled in regular rows with a thin covering of carbonizing material between the layers; and, when filled, the surface is covered with a kind of clay which vitrifies in the process

the machines for filling the cored carbons. The material for this purpose is a secret preparation, and is much like a thick metallic paint, and is ground and mixed in a special designed machine, when it is forced into the cavity of the carbon under great pressure on a hydraulic machine, in which the pencils are placed one at a time and filled about as fast as the attendant can put them in and take them out.

Such pencils and brushes as require to be copper plated are taken to the plating departments, of which there are two, one for the brushes, in which the plat-

THE COST OF A TRAIN MILE.

It is difficult to state just what constitutes a train mile. On some roads a great deal of extra or helping mileage is necessary, which makes double engine mileage; others figure differently. Many roads reckon train mileage according to the mileage of train crews; the "run" of a conductor one way is called a "train." This is probably the simplest way of stating train mileage.

The question of train mile cost is interesting and worth noting. The table which follows gives the cost per train mile of the various items of expense governed by train mileage more or less directly. In dividing certain expenses between passenger and freight, arbitrary methods have necessarily been adopted, but there is not much difficulty in getting a basis of fair division. We give the cost per freight-train mile:

	Cost per Train Mile.
1. For enginemen, firemen, fuel and supplies.....	22-138c.
2. For repairs of locomotives.....	8-064c.
3. For repairs of cars.....	19-880c.
4. For certain items of maintenance of way.....	4-135c.
5. For train service and supplies.....	11-564c.
6. For superintendence, loss, damage, miscellaneous, etc.....	6-006c.
Total.....	71-787c.

The passenger-train mile shows the following cost for the same items:

	Cost per Train Mile.
1. For enginemen, firemen, fuel and supplies.....	11-250c.
2. For repairs of locomotives.....	6-082c.
3. For repairs of cars.....	7-990c.
4. For certain items of maintenance of way.....	4-043c.
5. For train service and supplies.....	5-672c.
6. For superintendence, loss, damage, miscellaneous, etc.....	5-888c.
Total.....	40-925c.

—Mining and Scientific Press.

THE WASTE OF SHIPPING.

A RETURN just issued by Lloyd's shows the vessels lost, abandoned, or condemned during the quarter ending December 31 last. The wastage of steam tonnage during this period has amounted to 141,596 gross tons, while that of sailing vessels has been 121,342 tons. About one-half (73,918 tons) of the steam tonnage removed from the list was owned in the United Kingdom, the next heaviest sufferer being the United States of America, with 12,275 gross tons. To the figure above given for the United Kingdom, there should be added 5,027 tons for Colonial account. British losses represented $\frac{1}{5}$ per cent. of the gross tonnage owned, and those of the United States 1.04 per cent. of the tonnage owned, while in the case of Germany, on the other hand, the wastage for the quarter was only 0.24 per cent., a figure much below that of any other nation. Speaking generally, wrecks are responsible for about half the losses experienced, while collisions and abandonments at sea represent each about another one-eighth, while old age and wear and tear are responsible for the condemnation of about one-tenth, so that about 85 per cent. of the steam tonnage removed from the shipping list is accounted for under these four headings. In the case of British-owned boats, however, the loss from collision is proportionately much less, being only one-tenth the total, while owing no doubt to the practice of selling old boats to foreigners, the tonnage condemned is also comparatively small, viz., 5,280 gross tons out of a total of 73,918 tons. Coming to sailing vessels, the losses of the United Kingdom amounted to 13,007 tons, to which should be added 3,472 tons as representing the Colonies. The lead is, however, taken by the United States with a loss of 41,004 tons, equivalent to 3.22 per cent. of her total sail tonnage. Norway comes second with a loss of 24,458 tons, but the proportionate loss is, in this instance, less, being but 2.39 per cent. of the sail tonnage owned. As in the case of steam vessels, the proportionate loss is least in the case of Germany, but 2,777 tons or 0.59 per cent. of this country's sail tonnage being taken off the list during the quarter named. England, however, also makes a very good showing in this regard, her loss, mentioned above, representing 0.64 per cent. of her sail tonnage.—Engineering.

(Continued from SUPPLEMENT, No. 1236, page 19808.)

THE RELATIONS OF PHYSICS AND ASTRONOMY TO THE DEVELOPMENT OF THE MECHANIC ARTS.*

By Prof. CLEVELAND ABBE,

United States Weather Bureau, Washington, D. C.

VIII. EDUCATION IN SCIENCE AND TRAINING IN ART ARE MUTUALLY HELPFUL.

If science both stimulates the arts and feeds the artisan with necessary physical data; if the laboratory of the investigator and the workshop of the artisan are thus intimately associated together, how is it with the young men themselves who are to become either artisans or scientists? How is it with the education of our youth? Fortunately, laboratory practice or the teaching of physics by means of systematic personal experimentation in appropriate laboratories has been introduced into all of our best institutions of learning. It is now clearly recognized that the only satisfactory education is that which gives the student both a knowledge of the discoveries of others and personal practice in the art of discovery. The study of nature is not conducted by haphazard methods, but is itself a highly developed art. The courses in practical arts and the courses of scientific study should not be widely separated, but should be considered as being essential portions of one course of education.

In an address delivered in 1893, at Johns Hopkins University, the Hon. S. T. Wallis said that no phrase illustrates the action and reaction of the practical man and the scientist upon each other better than that due to Mr. Huxley: "While all true science begins with empiricism, it is true science only in so far as it strives to pass out of the empirical stage into the deduction of empirical from more general truths." The average citizen imagines that the learned man of research is set apart from everyday life. He needs to be reminded daily that the electric light, the incandescent Welsbach, the brilliant acetylene, the ordinary gas light, are all evolutions which the practical world owes to the physical laboratory; that not only the electric motor, with its halo of mystery, but the ordinary steam engine, which is but little less mysterious to the uninitiated, and the turbine wheel, which everyone imagines he can admire intelligently, are wholly the creations of the practical scientists who have given of their knowledge freely to the world of mechanic arts.

We must not attempt to separate investigation and education from invention and manufacture. We need to bring them closer and closer together than ever. I may quote from Dr. Wallis the case of a fireman or engineer of many years ago, in the days when the explosions of boilers were more frequent than now, and were an important object of investigation by the Franklin Institute. His boiler had exploded disastrously; he was called upon to give his testimony, and proceeded to state that "no one could know anything about these things except a man who had been brought up in the boiler room, and that the particular explosion in this case was, undoubtedly, due to the gases in the boiler." When asked what gas, he replied with an air of triumph: "How can I tell? I was not inside the boiler." Fortunately, such ignorant men are not now allowed to have control of boilers and human lives. Safeguards and protective devices of all kinds have been attached to the boilers, and, indeed, all other kinds of machinery; but, after all, the essential element of protection lies in the training and intelligence of the men in charge. It will be a happy day when every university has attached to it a school of mechanical engineering, so that the practical world of action and work may profit all the more by the scientific wisdom and broad learning of university scholars.

These crude remarks of mine will, perhaps, have already accentuated the importance of a thorough education along mechanical and physical lines, if one intends to devote his life to the improvement of the mechanic arts. As I have said before, one may, by a fortunate and accidental collocation of ideas, be put in the way of making an important invention or improvement; but the chances are all against this unless one has been pursuing such a course of education and training as will have fitted him to recognize the importance of the ideas when they suddenly occur to him, and to embody them appropriately in the metal and material of which his machine is to be made. Many a bright thought occurs to those of us who have not trained skill in the art of composition, and, therefore, we fail to become poets and musicians; many a man witnesses daily some little operation going on about him, but fails to make it the basis of a new process in the mechanic arts, because his thoughts do not run that way. In general, the most important improvements in machinery originate with those whose daily work familiarizes them with the special subject and its needs. It is fortunate that the tendency of the present generation is very decidedly toward the thorough education in physics of those who inherit a liking for machinery, in the belief that thereby they will certainly be better prepared to contribute toward the advance of our arts and to compete with those who, throughout the world, are revolutionizing the progress of civilization. America holds its own with England and Europe in this respect.

The following prominent training schools may be mentioned:

The Sheffield School of Engineering, at New Haven, founded in 1847, but in 1860 changed to the Sheffield Scientific School of Yale University.

The Lawrence Scientific School, with its recent addition of mechanical engineering, founded in 1847, at Cambridge, Mass.

The Massachusetts Institute of Technology, founded in 1861.

The Worcester Polytechnic, founded in 1865, at Worcester, Mass.

The Packer School of Engineering, Lehigh University, Bethlehem, Pa., founded in 1866.

The Stevens Institute, at Hoboken, founded in 1868, opened in 1871.

The Sibley College of Mechanical Engineering and the Mechanic Arts, at Cornell University, Ithaca, N. Y., founded in 1870.

The Case School of Applied Science, at Cleveland, O., founded in 1877.

The Rose Polytechnic, at Terre Haute, Ind., opened in 1883.

The graduates of these institutions are now everywhere coming to the front in our workshops, in the Patent Office, in the manufactories, and even in our politics, for, of course, the practical mechanic and engineer must be represented in the State and Federal legislatures.

I notice that in Germany both merchants and manufacturers have lately united in stimulating the education of mechanics and artisans as an important step toward improving the quality of their goods and the condition of German trade. The manual training schools, the workmen's trade unions, and other interested parties in the city of Hanover have resolved to establish advanced lecture courses, in which artisans and apprentices in all trades shall have an opportunity to complete their education in mechanics. Only those will be admitted to the classes whose theoretical and practical knowledge is such as to give promise of success. Great care will be taken to teach young men how to obtain the most practical advantages from the knowledge imparted in the classes. A permanent exhibition of all power machines and tools will be established.

The needs and opportunities of a great technical college were forcibly set forth in 1893, in an article by Dr. R. H. Thurston, director of the Sibley College at Cornell. After enumerating the large sums of money devoted to the support of educational institutions, he called attention to the fact that technical education in the mechanic arts, strictly so called, had not—and we may still say has not—been sufficiently provided for. The present demand for trained electricians but emphasizes the great need of training in every department of the mechanic arts. The provision for culture in literature, history, pure science, and the fine arts is far better; but that for technical instruction, manual training, and the art of doing as well as thinking still calls for attention. Laboratory or engineering research is especially to be desired. Every piece of machinery that we are using to-day is in itself a field for investigation as to whether it is doing its work with the greatest efficiency and in the best manner possible; but such investigations demand a previous knowledge of the laws of mechanics and familiarity with mathematical methods such as the technical schools alone can give.

The passage of a nation from barbarism to modern civilization occupies a long time, and is always attended with a great increase in density of population, and a great rivalry between individuals competing for success. The interaction between all classes of the community grows more intense; those who are on top struggle to keep their advantage by calling to their aid all the resources of power and intelligence. Experience has demonstrated that in this contest intelligence wins, and that knowledge is power. There can, therefore, be no doubt of the wisdom and statesmanship of the community that improves every possible opportunity to develop the natural resources of its territory and the intelligence of its own citizens. Both in Europe and in America, universities and surveys, arts and manufactures, morality and science, health and prosperity go hand in hand. Victory flies to those who are best prepared; peace rests with those who nurture the arts of peace.

President Eliot has nobly said: "It is the regular pursuits and habits of a nation in time of peace that prepare it for success in war, and not the virtues bred in war that enable it to endure peace."

From this point of view—the highest that any philosopher has yet attained—we see at a glance the wisdom of those citizens who have encouraged the development of both material and intellectual resources. I join the material and the intellectual together, for neither is of use without the other. If it is the mind that studies nature, it is also the mind that conquers nature. The intellect is developed, strengthened, and quickened in this struggle with nature. A university includes every possible variety of education, theoretical and practical; mechanics and physics, the laboratory and the workshop. It stores up knowledge, but only to diffuse it again in perennial streams.*

[Remarks of Prof. A. S. Mackenzie, Bryn Mawr College, "On the Claims of Abstract Science to a Place in the Franklin Institute."]'

Prof. Mackenzie.—Prof. Abbe has given us to-night a beautiful example of the value of theory when turned to practice; we all know of his researches on clouds and the clearness of the earth's atmosphere, but to-night he has descended from the clouds and shown his power to provide with a clear atmosphere the subject of the relation of pure science to the mechanic arts. I have listened to his remarks and those of Prof. Mendenhall with very great pleasure, but with a good deal of trepidation, for I fear that what I may have to say will but traverse the ground they have already so fully covered. Perhaps, however, I may be pardoned some repetition, for I believe that too much stress cannot be laid on the importance of the subject upon which Prof. Abbe has chosen to address us, and that progress in the future is to be made only by the theorists and the practical men keeping in the closest touch with one another's aims and needs.

It seems to me that the event in the history of the Franklin Institute which we are assisting at to-night is a notable one in its progress, and one which shows the high ideals of the society and the broad aims of those to whom its management and direction are intrusted. We learn from the full title of the Institute that its aim is the promotion of the mechanic arts, and we read of its sections devoted to mechanical, electrical, chemical, mining and metallurgical engineering as

* Even while this was being said in Philadelphia, a most favorable endorsement of these views was offered elsewhere, in that a stirring letter from Andrew Carnegie turned the subscription lists for the new university at Birmingham, England, very decidedly toward the promotion of applied science rather than merely literary and scholastic work. The immense iron and steel interests that center in Pittsburgh owe their development to Carnegie's foresight in securing young scientific experts to manage each department of his works. He urged that Birmingham should make science the principal and classic the subsidiary department of education; that the Midlands might retain its prominence as the British manufacturing center. The question is not one of markets or of transportation, but of skill and economy of manufacture. He who has such a thorough understanding of chemistry and physics that he can manufacture the best article will be sure to find a market and to overcome the difficulties of transportation. "Knowledge is power."

Mr. Carnegie's great gift to Birmingham will surely redound to the benefit of the whole English-speaking world.

a matter of course. At first thought it might cause surprise that it had a section devoted to theoretical chemistry, and that it was proposing to add a physical and astronomical section; it is, however, but living up to the many-sided character of the man whose name is so intimately connected with it, and whose investigations in the realm of abstract science are an integral part of our studies of to-day; and I think that not until now can the Franklin Institute be said to have reached the standard set by its founders, or to have been quite rounded out in its various functions.

The line of progress and development of the society has been a natural one in this new and rapidly-growing country, where the production and improvement of appliances for the rapid development of the country's enormous resources have called to their aid the best thought and energies of its people. As a consequence, the technical side of science has been advanced more rapidly than its theoretical side; it is true we have had a Franklin and a Henry, but the production of such men has been spasmodic, and until quite recently the study of physical science was but nominally existent in this country, whereas now great strides forward are being made, and the names of Rowland, Newcomb, Gibbs, Michelson, etc., are known in every corner of the scientific world. It is more than a coincidence, I think, that to-day the Franklin Institute is forming a section devoted to physics and astronomy, and that the physicists of the country meet at New York to-morrow to found an American physical society; it proves that at last there is an awakening to the necessity of the study of science for itself, and to the belief that we are fit for better things than to be a nation of shopkeepers and inventors only.

To the problems of engineering and technical science in its widest sense the Franklin Institute has in the past devoted most of its energies, and with great and growing distinction; the inventor or thinker to whom a John Scott or other medal of the Institute has been awarded has a recognized standing the world over, and the Journal of the Institute is consulted regularly by all engineers who wish to keep abreast of the progress in their special fields, and to follow the newer and more important processes and developments of their chosen work. But surely it is not necessary to add that, inasmuch as it has not had among its sections one devoted to the study of physical science for itself, without thought of material gain or useful adaptation, it has lacked one very necessary part of an advanced organization devoted to mechanical science. I consider it a great privilege to be present at this auspicious opening of the physical and astronomical section. The able address of Prof. Abbe, whose reputation, already so well known, will not suffer from the interesting lecture we have just listened to, has emphasized the absolute necessity of a close communion between the men who are willing to be the devotees of pure science and those whose ideals are in a direction equally valuable, and the results of whose labors are felt directly by each one of us at our every turn. It is upon this necessary working together of these two groups of men that I think we should at this meeting lay stress.

A science must exist before applications of it can be made, and hence the two divisions of the great work fall into the hands of two different sets of workers; and the nature of the work and the composition of mind required are quite different in the two cases. Not to the pure scientist belongs all the credit for the making of a science; the mechanic or engineer can, by constant thought and application, so get at the very heart of things that he becomes a co-worker of the theorist and advances our knowledge of the inner workings of nature; for a mathematical knowledge is not essential, it is a help and a valuable one, and the man armed with this weapon for attacking a problem is at an advantage, provided he does not become lost in his symbols; and it must not be forgotten that Faraday wrought out his great work in the field of electricity without mathematical equipment of the higher variety. It is, however, to the theorist, not to the technical man, that we must look for the advancement of science; but this advance can never be so rapid as it should be unless both theoretical and technical men recognize their mutual dependence. Du Bois Reymond has somewhere remarked that there is no abstruse investigation into nature that does not at some time have its practical application, and, this being so, how essential it is that this investigation should proceed on a clear knowledge of the work done and being done by practical men. Perhaps no better illustration of the value to the theorist of a knowledge of the technical requirements of his subject can be found than in the development of the study of thermodynamics; it was the work of Watt and his successors that led to the brilliant achievements of Carnot, Kelvin, Clausius, Maxwell, Hirn and others. Our whole knowledge of the laws of energy is almost a consequence of the researches called into being by the demands of engineers to know the principles underlying the working of the heat engine. The theorist thus receives a constant guidance and check as well as incentive, and is forced to give a reality and definiteness to his speculations which might otherwise remain in the clouds and whose full significance would be known not even to himself.

But to the technical man the assistance of the theorist is of much greater value. In addition to the direct aid afforded to the engineer by the new principles and discoveries of the theorist must be mentioned the fact that the theory not only guides the engineer in the direction of possible development and improvement, but that it acts as a beacon to warn him from the many directions in which his genius and labor would be barren of results because he aims at the impossible.

There never was a time when, more than now, the technical man must work hand in hand with the pure scientist. It requires the finest theoretical knowledge to devise a telegraph by the aid of which eight or more messages can be sent along a single wire in each direction at the same time, and yet we ordinarily consider telegraphy a purely technical subject. The engineer who would keep up with the pace which science is making must consider himself always in the schools; he must be trying to keep step with the changes in the theory and with the growth of knowledge as proclaimed from the studies and the laboratories; he must, if he would win distinction, have the training

* Address delivered at the inaugural meeting, May 19, 1899, of the Franklin Institute and published in the Journal of the Institute, to which we are indebted.

which fits him to seize the idea behind the theorist's symbols and forms, and strikingly apply it to the everyday problems in which his interests and labors lie.

The brain of the genius who can fasten upon the practical consequences of an idea brought forth by the mere thinker is one of the very highest order, and he deserves the merit he receives, and the world is quick to reward him in its substantial way, although the world is little able to discriminate, and is willing to believe the scribbler of any magazine article who prophesies plausibly a sudden demolition of the laws of nature which the labors of the greatest thinkers have placed on the most enduring bases. Just now we can see an example of such a thing with regard to the law of the conservation of energy; we are threatened with most improper doings by liquid air, and we have not yet forgotten the Keely motor. It is to the credit of the scientist that he is willing to give his life to the prosecution of learning for its own sake, and that, too, when an understanding and appreciation of his labors must be given to few. How common it is to hear that man who has made some application of value (measured in money or utility) lauded above the originator of the idea. One hears of this or that inventor of the electric lamp or dynamo, but not of Faraday, who made an electric arc fifty years earlier, and produced the electric current by induction and foreshadowed all its applications. One hears of a Hertz or a Marconi, with their electric waves and wireless telegraphy, but how seldom of a Clerk Maxwell, whose seething brain put forth the thoughts of which these things are but adaptations. How often is Lord Kelvin's name connected with the problems of submarine cable? One is almost tempted to say that the person of so-called average intelligence gives in his heart greater credit to the inventor of "See that hump?" than to the discoverer of the law of gravitation. Surely equal credit must be given to the originator of an idea with him who applies that idea to the purposes of mankind; and it must come home to us how necessary is the existence of a close bond between these sets of workers, so that each aids the other and to each is given the credit which is his due.

Now I believe that not only will the founding of a physical and astronomical section bring about good results of this kind to the Franklin Institute, but I consider that it is only a beginning in the direction in which such an institution should be expanded. It should have its staff of professors, whose only duty it should be to pursue original investigation, and the results of whose work should be made known to the world through the Society. Of course such things cost money, and being a practical people we hesitate to give our money to what we please to call impractical purposes. I hope, however, that we have come to the conclusion that a full return for the money so spent is bound to come back to us in overflowing measure, though in indirect and unseen ways. It seems that our benefactors who give of their wealth to advance education are unwilling to pay for pure science; they willingly give their money to found and endow libraries, they give freely to art collections and to museums; but what case can we recall of the founding of a laboratory for research only, a place where a Rowland could be put and told to go ahead regardless of expense and enrich the world's treasure-house of thought? The German government has such an institution, and yet I would be sorry to see ours try to imitate it; for it would be difficult every four years to find a man of the right political complexion to take a well earned turn at the "job." At the Reichsanstalt, to which I refer, and with which Helmholtz was connected in his later years, is a vast equipment, with its experts, to be counted not by units, but by hundreds, who devote their time not only to standardizing apparatus, but also to the devising of the best and simplest forms of instruments and to the production of new ones; and in addition to all this is Prof. Kohlrausch, with a staff of fifteen or twenty assistants, whose only aim is original research in the field of physics. All the products of these men's brains and the results of their labors are given freely to the world. I know of nothing similar in this country in the domain of physics; Harvard College has one of its departments, the astronomical observatory, devoted entirely to research. Prof. Pickering and his associates give no lectures and no instruction in the observatory; they are expected simply to use their best efforts to promote our knowledge of astronomical science, and to this end are provided with a staff of forty assistants, and a fully-equipped observatory and library. What better thing could be done by one of our moneyed men, eager to utilize his great wealth for the good of mankind, than to found, in connection with this and similar institutions, a professorship in physics, assuring to one qualified to fill it a liberal stipend (for even a Newton must eat) and all the appliances and assistants his genius can employ?

Perhaps this has carried us too far into the future, and whether we shall ever come to this I do not know; but at any rate I believe that the Franklin Institute has made a move to-night which will redound to its credit and usefulness, and I have taken great pleasure in being present at its inception.

[Abstract of remarks of Dr. T. C. Mendenhall, President Worcester Polytechnic Institute, Worcester, Mass.]

Dr. Mendenhall spoke substantially as follows: The excellent and carefully prepared address of Prof. Abbe leaves little to be said by those who follow him. It is a real pleasure, however, to be able to congratulate the Franklin Institute on the realization of a plan which is a recognition, tardy though it may be, of the intimate relations between the mechanic arts and physical science, or, as some of us would be inclined to say, the dependence of the former upon the latter. When I read the subject for discussion, I wondered how it could be a subject of discussion at all, for I am sure everybody knows and admits that progress in the mechanic arts rests upon and is measured by progress in the physical sciences. But it is no ordinary event in the history of either that the Franklin Institute, which may be justly considered the foremost organization in the country whose primary object is and always has been the higher development of the mechanic arts and the encouragement of American invention, has organized a special section for the better development of its interest in the physical sciences. When one reflects upon the splendid work of the Institute in its chosen field, the outlook for the future of

this new section of physics and astronomy is most promising, and we are all confident that much important work will here be done.

It is impossible to speak in this hall without constantly recurring thoughts of the pioneers of American science.

It is entirely natural that the present should appear to be the golden age, and among the historians of science in this country it is too common to pass over the seventeenth and eighteenth centuries as relatively unimportant.

As a matter of fact, some of the most brilliant of America's contributions to science were made before the beginning of the nineteenth century and, counted in proportion to the population, the number of eminent scientific men in those days was fully as great as now, and along some important lines their share of the world's work was greater. Perhaps the first contribution from America to the proceedings of a scientific society was the first communication of Gov. John Winthrop, of Connecticut, to the Royal Society of London, of which he was one of the earliest members.

Another Winthrop, of the same stock, Prof. John Winthrop, of Harvard College, was also a frequent contributor, and doubtless did more to kindle and keep alive the fires of colonial enthusiasm for physical science during the eighteenth century than anyone else. But the one great figure of that period was one whose name and deeds are inseparably related to this city and in whose memory this institution was founded. The world has produced few, if any, more brilliant men than Benjamin Franklin. It is with only one phase of his intellectual activity that we are interested to-night, and in that alone, as a physicist or natural philosopher, no one will deny that he must be reckoned among the very foremost. There is one quality of his scientific work to which I want to invite special attention; it is the almost ever-present practical end toward which nearly every investigation was directed. On account of the great luster of his researches in electricity, it is often forgotten that he enriched nearly every department of physical science, and although he evidently did not lack capacity for that keen enjoyment of discovery which depends upon discovery alone and is indifferent to practical results, it is everywhere evident that with him the possibility of turning a scientific experiment or principle to good account as a means of bettering the condition of his fellows was paramount. There is a certain class of scientific men, not large and not increasing, we are glad to note, among whom it is the fashion to speak with what they believe to be a "fine contempt" of applied science, and who, having never succeeded in discovering anything of any particular value or use, pride themselves on pursuing science for the sake of science. And we have all heard of the mathematician who thanked God that he had at last discovered a formula of which it would be utterly impossible ever to make any practical use. But this doctrine has not been held by those most entitled to distinction in the annals of science, and Franklin was a notable example of those who believe that the noblest ambition by which a man of science may be stirred is the ambition to discover laws which may be utilized in the amelioration of the almost necessarily harsh conditions by which mankind is surrounded.

It is difficult to address a body of scientific men in this place without thinking of another great man, that of one who stood almost at the beginning of that long and unbroken line of astronomers for which our country is justly famous. And in thinking of Rittenhouse in Philadelphia one is likely to turn from the contemplation of his splendid career as an astronomer to that incident, so characteristic of the men of his time, in which the man of science became, at the behest of the Committee of Safety, the clockmaker again designing and casting clock-weights in iron which were to be exchanged with the inhabitants of the City of Brotherly Love for leaden weights, to be moulded into bullets, which contributed to the founding of a new nation. During the life of that nation the most marvelous changes have been wrought in the material condition of man and his relations to the planet which he inhabits. We have ourselves witnessed so many of these changes that detailed reference to them is unnecessary, but we may profitably inquire concerning the underlying cause of such a prodigious revolution. To my mind it is found and found only in the discoveries in physical science, and in their application to the control and direction of the forces of nature. Man lives in this world only by the continued transformations of energy, and his comfort and happiness depend largely on the amount of energy he is able to transform. It is not long since his only supply was that furnished by the muscles of his own body, but during the nineteenth century he has been able, thanks to physical science, to draw upon almost inexhaustible sources from without, and this is why he has progressed by leaps and bounds that have exceeded the most extravagant imaginings of our ancestors. This progress cannot be attributed to war, for war has existed since the dawn of history, and it has failed to lift man above the slavery of unintelligent toil. Nor is it due to religion, nor literature, philosophy or art, for all have flourished for ages without materially altering the relation of man to his environment. Science, with its unerring processes of observation, experiment and precise measurement, has inaugurated the peaceful revolution in social relations and material conditions, which the nineteenth century now passes on, still incomplete, to the twentieth.

The pen has conquered the sword, but the yard-stick is potentially the master of both.

What is asserted to be the oldest brick in existence was recently exhibited at a meeting of the Académie des Inscriptions et Belles-Lettres, of Paris, by M. Henzey, the keeper of the Louvre. It is supposed to date from the fortieth century before Christ and was discovered at Tello, the ancient Sirpulo, in Chaldaea, by the French archaeologist de Sarzez. The brick in question was curved in shape, and, while it had been baked, it did not show any signs of having been pressed or moulded. The mark of the maker was merely the impress of his thumb, and the specimen is, without doubt, one of the earliest marks of civilization ever discovered. As brick making is the earliest of the known arts, this particular piece must mark very nearly the dawn of civilization.—N. Y. Evening Post.

A NEW GLASS, AND ITS USES IN THE ARTS.

By WILLIAM DULLES, Jr.

GLASS in connection with chemistry has proved of little use, except in the laboratory, and in that for the smallest and simplest forms of chemical work. Its advantages are due of course to its great power to resist acids, whether liquid or in fumes, and electricity. Its transparency gives it further advantage in watching solutions, reactions, precipitations, and formations, while the fact that it can be given a perfectly smooth, compact surface makes it of pre-eminent sanitary value. Its limitations, however, are very marked, and are due to the difficulties which arise in treating it and forming it into shapes. Its most marked limitation is its fragility.

It has, however, other disadvantages growing out of practical conditions in its manufacture. When melted, it is not in any sense liquid, but rather plastic, cooling very rapidly, and thus preventing, under ordinary conditions, its being moulded into very large sizes. An added difficulty is its propensity to break from defective annealing.

Glass hollow ware has almost universally been produced by the process of blowing. It is a matter of astonishment that a man can become so skillful in blowing as to produce such an immense variety of blown tubes from the smallest pipe up to the window glass cylinder, and preserve a very accurate calibration.

The strength of glass is of course of two types, one mechanical, due simply to its thickness, enabling it to resist blows; the other internal, due to its chemical composition and annealing, enabling it to resist heat and cold and chemical influences. This is illustrated by the very familiar test tube, extremely fragile mechanically, and yet peculiarly strong for practical laboratory use.

The reason of course why a thin glass, well annealed, will resist intense heat is found in the fact that, glass being a very poor conductor of heat, the contraction and expansion caused by sudden heat will make the glass far more likely to break when thick than when thin. Collateral to this is the necessity for the test of heat and cold that glass shall be of uniform thickness, so that the contraction and expansion will not be different in the different parts of the same article. As a result, it has proved possible to make cylindrical glass articles in much larger sizes than any other shape, and blown jars and tubes have, as stated, been made in quite large sizes, though as a rule with less thickness of walls, and correspondingly less mechanical strength.

The essential element in the Appert process and the value of the glass produced is the successful meeting of the two difficulties thus far suggested. Mr. Leon Appert, himself a very well known glass expert and manufacturer, ex-president of the French Society of Civil Engineers and president of the Society of the French Glass Manufacturers, has devised and patented the machinery which bears his name. The well known St. Gobain Company took up the practical development of the matter, and has for some years been producing in very large quantities, with perfect success, rectangular and cylindrical jars and pipe of all sizes.

By means of a mould and core, mutually adapted to the form required, glass jars and pipe of symmetrical shape can be made, handled, and subsequently annealed. In the pipe there is no question as to making a bottom, but jars involve this decidedly serious problem, and special appliances are needed to secure a flat bottom and of true thickness properly in accord with the thickness of the said walls. Behind the mechanical operation is the composition and temperature of the glass itself, which is so controlled as to make possible the moulding of large jars in cylindrical shape up to say 40 inches high and 20 inches diameter, holding 50 gallons, and in rectangular shape up to 16 inches by 21 inches by 23 inches, and holding say 24 gallons.

The making of cylindrical jars proves somewhat easier than the making of rectangular jars in this process, following the analogy of blown work, but the thickness of walls and mechanical strength are in no way impaired or modified as the size increases, thus guarding the mechanical strength. Rectangular jars are much more difficult to make, but, if made at all, they must be and are of strictly uniform thickness, maintaining this same thickness at the curving of all the sides.

An ordinary blown rectangular jar is made by blowing a balloon reasonably spherical or ovoid. If such a balloon is moulded into a true cylinder, it will have uniform radii from a given center, and the glass will form itself with reasonably uniform thickness of walls about the sides of the mould. When, however, such a balloon is placed in a rectangular mould, there will be at once radii of different lengths, and the glass will be distorted, making very thin corners at the longer radii with thick sides. The result is thus mechanically weak, due to the thinness of the corners, where danger from a blow is greatest, and the impossibility of annealing a jar with so great a difference of thickness in its walls. The production of such jars by the blown process is both unsatisfactory to the manufacturer and the user. The Appert process, while able to make small jars, practically begins where the blown jar ends, competing not with glass articles, but with jars made of other materials.

The variety of jars to be made is simply a question of moulds, though each jar has a tendency to develop some little peculiarity of its own in the process of manufacture, and make a history for itself at the factory.

It will be noticed that the jars have somewhat fluted sides, and the impression is given that the jars are not transparent. This, however, is an incident, and the glass itself has the transparency of plate glass, the inner surface being in every case perfectly smooth, and the outer surface capable of being ground and polished with any degree of smoothness that may be required. A piece of glass from a broken jar polished on what had been the outer side shows that the glass is perfectly clear, and that the smoothness of the inner surface as originally made cannot be distinguished from the surface that has been specially polished. The jars are always made with more or less of an upright or vertical panel which is clear, so that graduation will

be possible. It is at once apparent to practical users of such articles that the inside of one of these jars is illuminated because of the transparency of the glass, which is unmistakably an advantage over any other form of jar. The perfect smoothness of the inner surface, already referred to, is an added advantage. The glass is also of such quality that faucet holes can be drilled of any required size in any location. Portions of the sides can also be polished so as to allow observation as to what is going on in any special part of the jar.

The variety of industries in which chemistry is involved is so great that one cannot easily venture to enlarge upon the possible uses of this glass. Inquiries that have come to the manufacturers indicate a demand ranging from the strongest acids to the purest distilled water.

These jars withstand marked changes in temperature within reasonable limit, thus proving themselves equal to the practical tests of laboratory and chemical work.

There have been many patents taken out for making glass pipe. Its value as a resistant to electricity and chemistry, as well as in sanitary projects, makes its use most attractive. There must be great difficulty in moulding glass into a long pipe with a comparatively small core. This, however, has been accomplished, and it is a most interesting thing to see one of these moulds opened, showing a piece of pipe 5 or 6 feet high, with the changing colors, as it cools and is taken rapidly by the workmen to be prepared for the annealing process.

For practical uses glass pipe must be very strong mechanically, and yet not overloaded with weight, which greatly increases the expense. A further difficulty is to retain a true roundness of the glass, with the extreme tendency which glass has to distort as it cools. This, however, has been perfectly accomplished. Again we find in this pipe a peculiar and perfectly smooth inner surface. These pipes have now been made in lengths of 5 to 6 feet, with an inner diameter of 4 inches. When the diameter is increased the length is diminished, but pipe has been made and can be made with diameters of 10 inches to 21 inches in lengths of one meter. The great mechanical strength of all the glass made by this process is due to the fact that it is extremely hard, perfectly annealed, and of a sufficient thickness to resist any ordinary blow.

There are many other forms into which glass can be made for chemical uses, and plans are now under way for making special forms for special requirements of chemistry and allied industries. The question is one of development, and the construction of new moulds in order to widen the circle of its application.

Under the general heading of electricity, we find electric storage battery work, which has made use of these jars in Europe for several years, and is beginning their use here as rapidly as the jars can be furnished. Electrolytic plants also find the advantage of the purity and permanence of glass as well as electroplaters and all the industries where electricity is concerned.

Pipe commands itself for the transfer of high tension electric currents. Some made of the glass have been tested, and show a resistance of 35,000 volts when dry, and 20,000 when wet.

In chemistry proper, we find these jars available for all processes using acids, while the pipe in different sizes meets the difficulties met in piping acids and acid fumes, and can also be made into towers such as are used in nitric acid and similar factories. An interesting inquiry has come in regard to using this pipe for piping sulphuric acid fifty miles from a point of manufacture in the mountains to the line of the nearest railroad.

The vital point of course is that glass is made available in much larger sizes than ever known heretofore, and it is evident enough that the qualities that have made success so universal in small sizes will make a corresponding demand for anything of any size that can be made of this unique material.—The Journal of the Society of Chemical Industry.

IVORY PRESERVED IN COLD STORAGE.

No one can estimate the amount of ivory that is hidden in the ice fields of the frozen regions near the poles, nor more than guess at the length of time it has been thus preserved. With the rapid decrease in the herds of elephants in Africa, the search for remains of the mammoth increases. From time to time reports are published of finds of frozen carcasses of these huge beasts, valuable for the mass of ivory in their tusks, in the tundras of the far North, mainly in Siberia. Science does not explain how the giant animals were able to exist in a climate that has preserved their remains by freezing, or how they chanced to be thus overwhelmed.

This mammoth ivory, far from being a recent discovery, was known to the ancients, and has been used for centuries as an article of commerce and manufacture. The records show that as early as 1821 ivory of this kind to the extent of 20,000 pounds was marketed in Yakutsk, and that annual sales in that city, from 1825 to 1831, averaged over 60,000 pounds. In 1840 Dr. Middendorff, who visited the vast territory, estimated that the annual output of Siberian ivory reached 110,000 pounds, representing at least 100 individual mammoths. Baron Nordenskjöld estimated in 1875 that fully 20,000 Siberian mammoths had contributed their ivory to the world's markets since the conquest of Siberia.—Ice and Refrigeration.

In a paper on determinations of the refractive indices of solutions, communicated to the Isis Society, of Dresden, W. Hallwach gives an account of a differential method with grazing incidence, for which a double-slit refractometer has been used. The process described has been applied to solutions of bromo-cadmium, sugar di- and tri-chloroacetic acid, and their potassium salts; and the author investigates the relation between the refractive index and the degree of concentration, with a view of determining whether it is influenced to any extent by dissociation. The experiments show that such an influence, if it exists, is too small to be measurable with exactitude. This result is at variance, in the case of bromo-cadmium, with those obtained by Le Blanc and Rohland, but the discrepancy is attributed to an error.—Nature, 60, 329.

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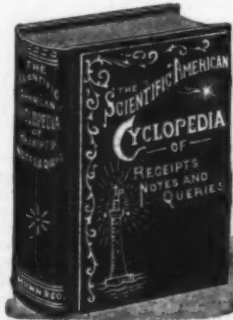
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